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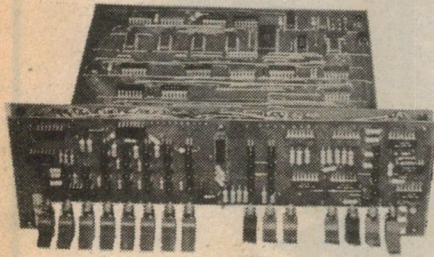
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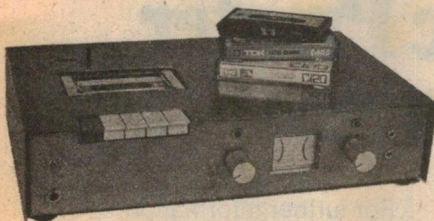
Australia's largest-selling electronics & hi-fi magazine

VOLUME 36 No 5



This is the "works" of a unique home construction project — a complete digital micro computer! The first of a series of articles telling you how it works, how to build it and how to use it begins on page 42.

Have you sent in your entry to the Practical Project Competition yet? Don't forget that all entries must be postmarked not later than Monday, September 2nd. There are valuable prizes from Kits Australia Pty Ltd, to be won, plus the chance of getting your project published in E-A. So don't delay!



Here it is at last, the stereo cassette tape deck design you've been waiting for. Easy to build, it offers many attractive features, including twin level meters and overload indicators. See page 54.

On the cover

An operator testing colour TV deflection yokes at the Philips Elcoma factory in Hendon, South Australia. Deflection yokes for colour receivers must meet very stringent requirements if accurate convergence and colour purity is to be achieved, and this calls for careful testing. (Picture courtesy Philips Industries Ltd.)

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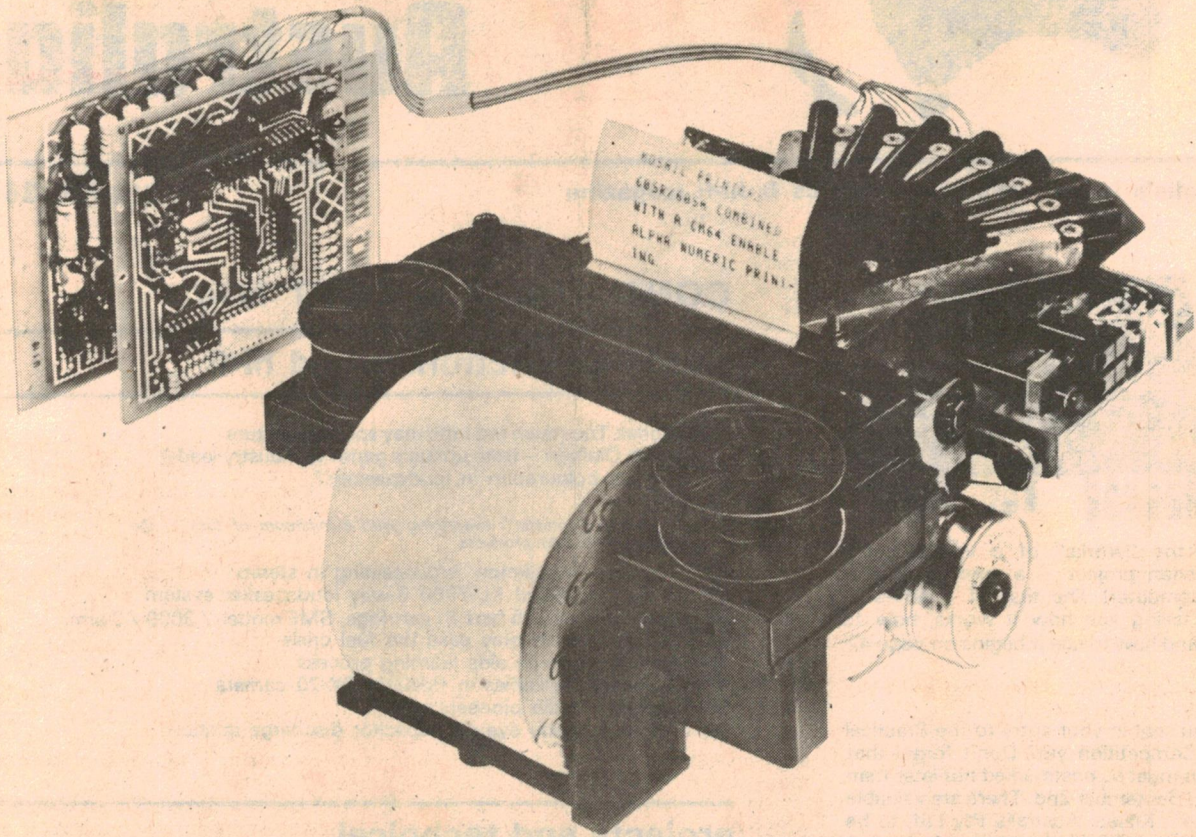
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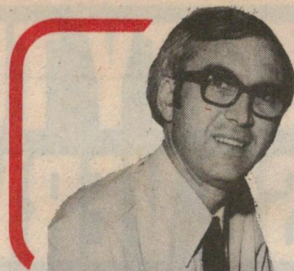
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Editorial Viewpoint

Too much red tape may spoil the picture

With the colour TV era just about to dawn in Australia, one of the things I find most disturbing is the situation in the servicing side of the industry. Almost equally worrying is the way in which the likely problems of servicing are apparently being glossed over, minimised and even ignored by many who claim to have the interests of the consumer at heart.

Servicing has always been the Cinderella of the electronics industry, as it has been in many others. I suppose it was only to be expected that it would continue to hold this lamentable position into the colour TV era. Yet when C-day was announced, quite a reasonable notice period was given, and it is disappointing that since then more has not been done by way of technician retraining.

The state-run technical colleges have been doing their bit, but considering the size of the problem, they have made only a modest impression. In a letter recently published in the Sydney Morning Herald, the Director of the NSW Department of Technical Education noted that to date some 200 technicians had completed his department's course in colour TV servicing, while a further 165 were currently enrolled.

In view of these modest numbers it was disappointing to learn that the department apparently restricts enrolment in the course to those who have completed formal radio trades and television receiver servicing courses. The reason given for this is that other applicants would not, in the department's view, be capable of becoming "properly qualified" servicemen.

This attitude is surely quite unrealistic in view of the fact that a majority of the service technicians currently working on monochrome receivers have no formal qualifications in the strict sense. Yet most of them, by virtue of their rich background of practical experience, are probably far more adept and efficient in their job than many who do possess that magical bit of paper.

To bar these people from enrolling in one of the few colour TV servicing courses which do exist seems to me nothing less than sheer bureaucratic conceit. It amounts not only to an insult to the technicians involved, but also to a refusal to provide many consumers with the trained servicing facilities they have a right to expect. And the technicians excluded from the course will still have to try and cope with colour servicing, less equipped than they could have been.

There are already very few young people entering electronics servicing as a vocation; I would estimate that the average age of current technicians would be between 45 and 50. This very serious situation isn't going to be improved by one of the main training bodies adopting a head-in-the-sand posture.

—Jamieson Rowe

PS: I am happy to admit that I was wrong, in the June issue, to suggest that the local manufacture of resistors and capacitors had ceased. Among others, IRH Components are very much alive and well, as Lloyd McCulloch's letter on p.87 testifies.

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BANG & OLUFSEN

It seems quite incredible that the sleekly styled hifi units for which B&O are now famous should have grown out of products which were once criticised as "Norman-arched and pot-bellied falsities . . ." This is one of the facts which special writer Tim Matthews discovered when he paid a personal visit to the Bang & Olufsen complex in Denmark.

Bang and Olufsen. The very name of the firm sounds like a hi-fi demonstration; you can almost see the timpanist leaning forward over his drums to muffle that final syllable.

Bang and Olufsen A/S, now internationally known for their high quality sound and vision equipment, was born in Kvistrup Manor, North Jutland, in 1925. The manor belonged to Sven Olufsen's father who regarded his son's enthusiasm for electrical engineering with a certain tolerant amusement.

Peter Bang, a school friend of Sven's, shared the same interest and the two boys were allowed, on sufferance, to potter about together upstairs under the manorial eaves.

After a time activity became so intense up in the attic that they were exiled to the garage. There is a photograph of that garage as it was in those days: at the work bench stands Aage Sigh, one of the company's first employees who is still at work with B&O. At that time, he recalls, he was making transformers. "with the utmost economy in materials".

From its earliest days it was the policy of the firm to produce equipment of the highest possible standard, with no shortcuts taken in order to lower prices. With hindsight it may be said that it was a philosophy without which the company would almost certainly have not survived; what was once no more than an instinctive 'feeling' is now the formulated marketing policy of the company.

One of the first contracts which the new company landed was to provide a set of loud-speakers for a new production at Det Kongelige Teater in Copenhagen. Aage Sigh remembers working with Sven Olufsen on the installation.

Finally, after many hours of dusty work, the moment came to switch on the equip-

ment. It was the day before the dress rehearsal; the valves hummed and glowed and Sven Olufsen felt the moment had come to test his loud-speakers at full volume. As he turned up the controls the effect was dramatic. The powerful Bang and Olufsen speakers surpassed all expectations, and as the amplified sound boomed out into the auditorium four metres of the ornate plaster ceiling of the theatre came crashing down into the stalls.

In spite of temporary setbacks people appreciated the new Bang and Olufsen products and the firm began to grow fast. By 1927 it was decided to build the first 'custom-made' Bang and Olufsen factory at Struer, a small village about 15 kms north of the manor house.

Olufsen pere still had his say in the conduct of affairs, however, and it was he who dictated that the new building should be built in such a fashion that it could 'if necessary' be easily converted into an agricultural college. (Some employees, looking round at the assorted collection of buildings which, today, make up the B&O Struer complex claim that this philosophy has been followed ever since.)

Struer is located in an agricultural area, and although the population of the town is now some 17000 — mainly employed by B&O — the outlook is still rural and the farming locals have still not comprehended the strange 'new fangled' industry which has grown up in their midst.

Over the years Bang and Olufsen prospered, but during the war (as a result,

it is said, of having supplied the Danish Resistance Movement with radio sets) the Germans blew up the factory.

After the war the 'agricultural colleges' were re-built and production began once again. B&O was in the forefront of technical development and in 1953 produced one of the first transistor radios in Europe. But as the post-war demand for radio sets and television mushroomed, it has to be confessed that a total confusion of style and decoration began to overwhelm the industry.

In 1954, for the first time, the radio industry was invited to show its wares at the Danish Joiners and Cabinet Makers annual exhibition. Bang and Olufsen's Product Development Manager, W. L. Vindelov, was particularly proud of the company's top model at that exhibition, The Grand Prix, which he had designed with personal pride in the style of the day.

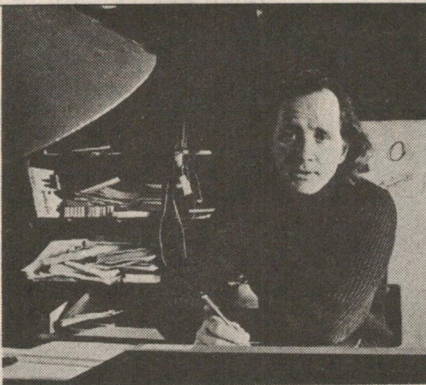
He was delighted, therefore, when he saw that a photograph of his model had been chosen to illustrate an influential review of the exhibition. But his face fell when he began to read the accompanying text. It described the radios, his radios as 'eyesores'. It was an insult to ask people to buy them, it said. "Norman-arched and pot-bellied falsities with flourishes, hangings and trappings, usually made out of the most repulsive choices of wood, and plastered with plastic and brass. It makes one sick to see so much lack of inspiration gathered into one place."

Engineer Vindelov took a deep breath and read on. "The old-fashioned lavatory-door in its most bovine state has obviously been used as an inspiration for almost all the loud-speaker gratings, shouting to the sky to complete the work by putting a slop-pail and an old newspaper in the box, which paradoxically contains one of our era's technical marvels."

To give him credit, Engineer Vindelov realised, after his initial fury, that the criticism was quite justified. It was a turning point for Bang and Olufsen who, chastened, determined to start work in co-operation with a number of leading Danish designers.

The first fruit of their labour in 1957 was to be a slim-line radio, later named the Beomaster 900, which both internally and externally created history. It turned out to be a master-mold in which most radio design of the 'sixties would be cast.

The company was still in an uncomfortable position, however, since they had not completely jettisoned the lavatory-door design. An uneasy alliance between the two looks continued to jog along until, in the mid-sixties, Jakob Jensen, a young industrial designer who had just returned from studying in the United States, was invited to join B&O.



B&O Industrial designer Jakob Jensen.

Tim Matthews, 45, educated at Downside and Cambridge University, has spent most of his working life in broadcasting. He is still a regular contributor to a number of BBC radio programs. His contacts with BP were forged when asked to produce a programme about the company for the BBC's General Overseas Service. (Reproduced from "B.P. Shield International", monthly journal of the British Petroleum Co, London)

It is really from that moment that it can be said that B&O realised the vast contribution that design could make as an integral part (not a complete goal in itself) of its production. Today there is always a designer working with every project team, and his contribution is given as much emphasis as his technical colleagues.

"It's taken us years to build up this co-operation," says B&O's international advertising manager Jorgen Palshoj, who certainly does not under-estimate the importance of design. "Design is communication. And communication is the business we're in. It's communication about what the product is — I am a gramophone — and what the product can do.

"It is communication between man and machine." As a small illustration of the last point, Bang and Olufsen insist that all knobs on its products must be designed to respond positively to human touch, to communicate, not merely light up like a modern lift button.

Yet in spite of the high technical quality of their products, B&O insist that they are not producing goods for 'hi-fi enthusiasts' — those earnest and knowledgeable men with small screwdrivers, soldering irons and annual subscriptions to a technical hi-fi journal.

Bang and Olufsen are making equipment for the man-in-the-street who appreciates quality but does not want to be involved with the mechanics and maintenance.

One hesitates to repeat the well-known cliché, but B&O are the Rolls-Royce of domestic electronic entertainment. 'Domestic electronic entertainment' may seem a bit of a mouthful, but this, too, is part of the B&O philosophy.

They are not interested in making professional studio equipment, nor — in spite of their initial success at the Royal Theatre in Copenhagen — in supplying public entertainment equipment. "We must do what we are good at. And that is making sound equipment for the home."

Sound equipment, then, is what B&O is really all about, although they do make television sets as well. Somewhat reluctant! "Since we do not produce or influence the development of the main components in TV products, our possibilities for economical production of independent and original products are much less in the video area than in the audio area," says one of the company's press handouts.

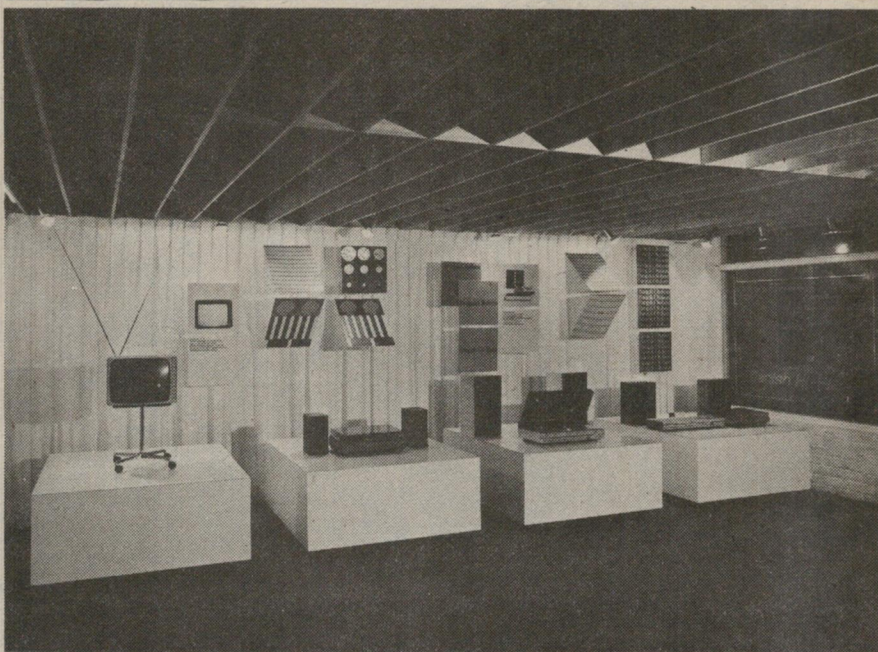
"B&O must, therefore acknowledge that although the product policy for TV is, of course, the same as for the audio area, from an economic point of view and with regard to the product itself, it is not possible to live up to this policy in the area of video to the same degree as it is in the area of audio. However, because of our distribution policy it is highly desirable to market video products too."

Distribution and marketing has an important part to play in B&O's philosophy as design and technical expertise. To maintain its exclusive image B&O is anxious that its products should not find their way into the pages of mail-order catalogues or the shelves of discount stores.

To this end it has built up a strictly-controlled dealer network. Without technically and commercially qualified radio dealers they feel they will have difficulties in getting their products handled with the special attention and care which they demand.

To preserve this network intact B&O has recently made an official request to the

50 YEARS IN DENMARK, 10 IN AUSTRALIA



Next year, Bang & Olufsen celebrate their 50th year of production of audio equipment — consummating a venture that began in the garret of the olufsen man or house in Jutland.

Today, B&O market a complete range of high fidelity systems, which are distinguished by their emphasis on styling, quality of workmanship and their emphasis on uncoloured audio reproduction.

Bang & Olufsen are represented in Australia by the GRD Group Pty Ltd — a liaison which is now of 10 years standing. A number of retail stores throughout Australia concentrate exclusively on B&O products, trading under the name Danish Hi-Fi Pty Ltd. There are two such shops in Melbourne at: 698 Burke Rd, Camberwell, 3124 and at Shop 9, Southern Cross Hotel, 95 Bourke St, Melbourne 3000.

In Western Australia, Danish Hi-Fi have

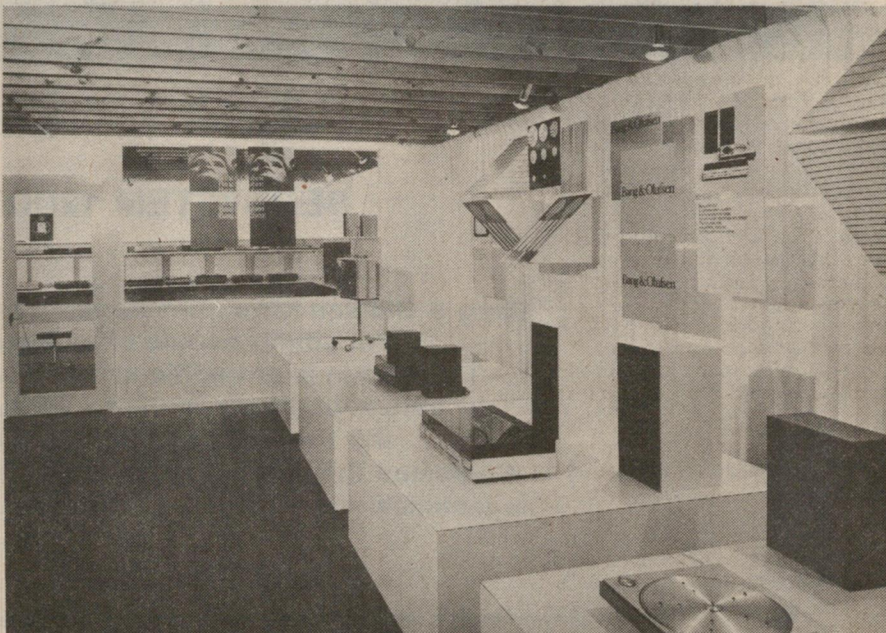
opened a store at 308 Walcott St, Mt Lawley 6050. Manager of the WA store is Mr Finn Neilsen, himself a Dane, who has worked with B&O in both Denmark and England.

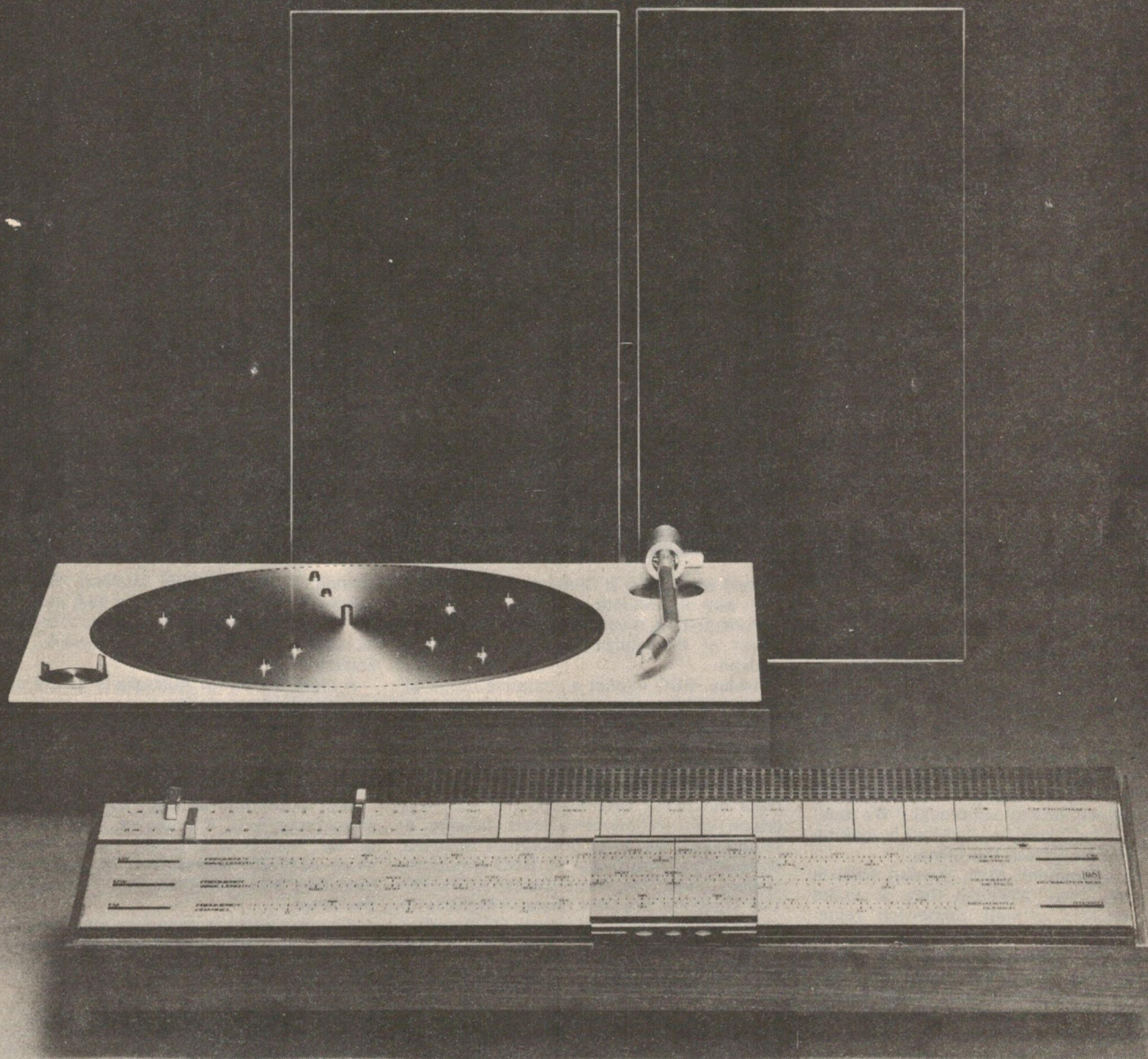
A store for South Australia is in the advanced planning stage.

A noteworthy feature of all the Danish Hi-Fi stores is their emphasis on clean, strong lines and natural materials, which complement the basic B&O styling.

One of the less obvious features of the showrooms is in the use of a "Beocomparator" which is intended to facilitate a more accurate assessment of alternative amplifiers and loudspeakers — particularly the latter.

Simple switching systems are misleading, because they cannot cope with variations in gain and sensitivity between different types of unit.





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Further information from ... Victoria - Danish Hi Fi (2 shops); N.S.W. - Convoy;
Western Australia - Danish Hi Fi; Queensland - Brisbane Agencies.

BANG & OLUFSEN

EEC for a dispensation (such as that granted for example, to Omega Watches) from the provisions of Article 85 of the EEC Rules of Competition which in a nutshell, provide that all manufacturers must make all their products available to and through all distribution networks which are interested in carrying them.

What are B.O.s 'available products'? In short, they are seven, elegant main systems which may be combined in various ways to give complete sound facilities to the home. They range in price from about 40 pounds for a portable radio to around 800 for the new Beo-system 4000 which incorporates ambiphonic data control, a sophisticated gadget which has taken over five years to develop which will 'read' any disc placed underneath it and automatically adjust the machine for speed and record-size. The system is based on wartime bobb-sights developed by the RAF.

B&O is proud that it produces everything from needle to loudspeaker and is somewhat disdainful of those who assemble their own equipment from various sources. A system, says B&O, "should be considered as a whole in which the individual parts are carefully matched to give the best possible results. For example our SP 15 pick-up is individually calibrated and adjusted to match the associated coil system and is therefore not interchangeable."

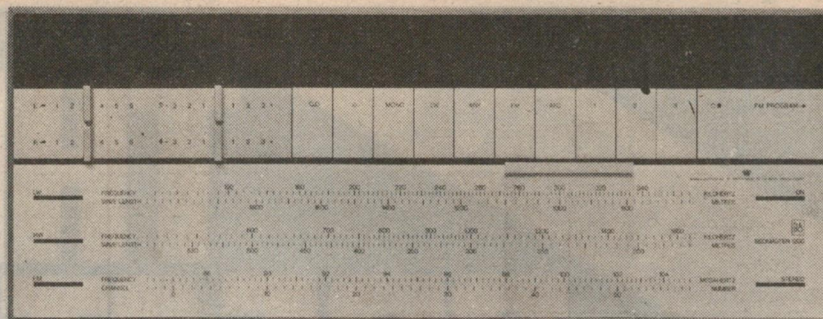
B&O has its own needles made (by a firm of diamond polishers in Wales), and its own loudspeaker cabinets (by 16 independent firms of carpenters in Jutland).

Bang and Olufsen resolutely refuse to 'colour' the output of their equipment and insist on producing the most natural sound (and picture) possible. To this end a special listening panel of 20 highly critical music-lovers is often assembled in the factory to pass comment on new speakers hidden behind acoustically-transparent curtains.

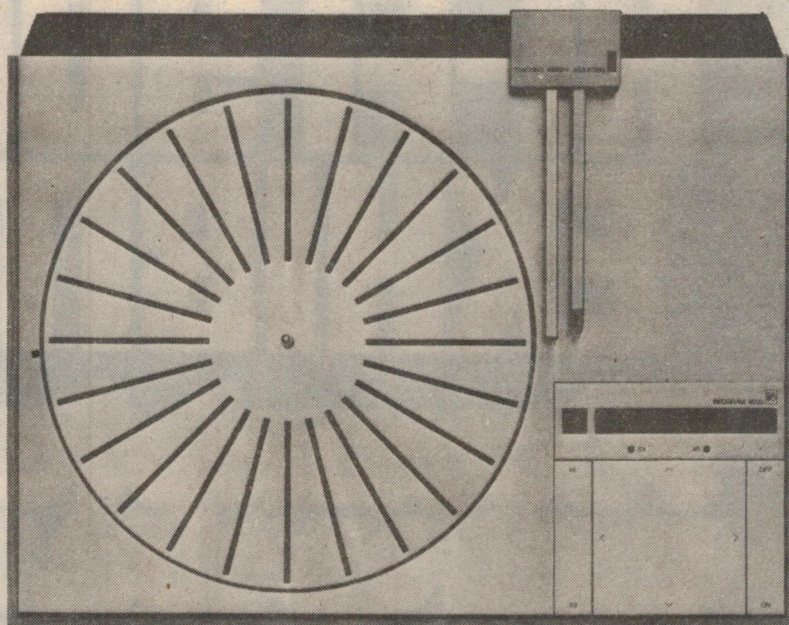
Colouration is fatiguing but difficult to perceive straight away; B&O engineers suggest that anyone buying new equipment should take along a couple of records of music that they know well to try out on unfamiliar speakers.

Unlike most radio manufacturers, B&O publishes a complete technical specification of all models. If for any reason one of their items does not come up to these

The Beocentre 1400 illustrated below combines AM tuner, FM/stereo tuner, cassette play and record and a full-scale amplifier with normal phono input facilities. Power output is 20W RMS per channel. Recommended retail price in Australia is \$530.00.



The Beomaster 1200 tuner / amplifier dramatises the B&O penchant for slide-rule type controls, which are mated here with matching function selector tabs. The stereo volume controls are at the top left, with the bass and treble tone controls alongside. Radio coverage is LW (long wave), MW (normal AM broadcasting) and FM / stereo which notably covers only to 105MHz. Power output from the unit is 15W RMS per channel. Recommended retail price in Australia is \$300.00.



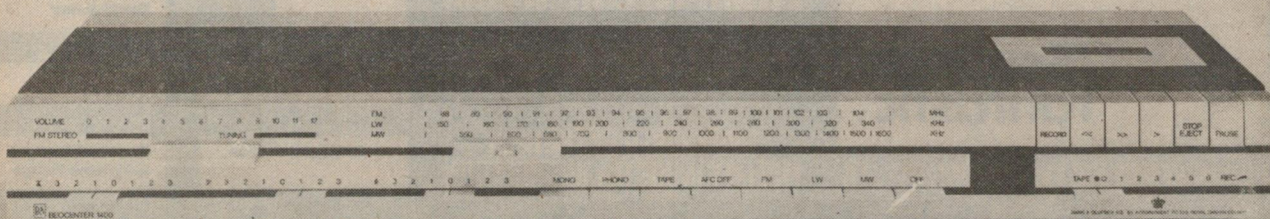
This Beogram 4000 electronic record player is a connoisseur item retailing for \$570.00. In-built sensing allows it to adjust automatically to record size and speed, while the turntable, is electronically speed regulated. The actual playing arm (on the right) is designed to achieve accurate tangential relationship to the groove.

specifications either on delivery or later on, the company will replace it.

In the past ten years B&O has seen its turnover jump from 3.5 million pounds to 27 million and its factory space grow by over 800 per cent. The company — still owned by 23 family stockholders — is determined however that this growth shall now be limited rather than expand at the cost of lowered standards.

These standards have already won the

company a number of international design awards, including the French Grand Prix and over 30 other international awards. And, though design by itself is not by any means the goal for B&O, perhaps the honour which is most appreciated by the men at Struer is the fact that recently the Museum of Modern Art in New York chose not merely one, but seven Bang and Olufsen products for inclusion in their Permanent Design Collection.



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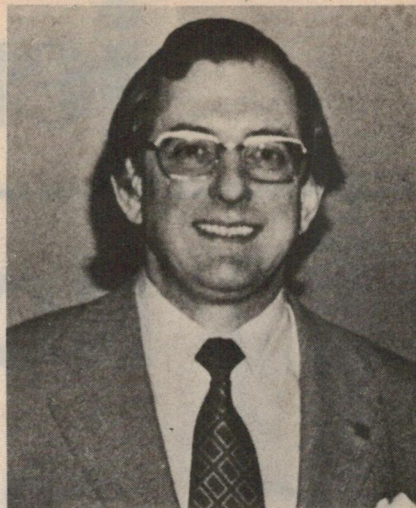
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◀ Wynyard Station	Town Hall Station ▶ ▼ Pyrmont Bridge

Why the colouration in loudspeakers?

Recent visitors to the Australian hifi scene were Mr Raymond Cooke and Mr Robert Cox, respectively managing director and sales director of KEF Electronics Ltd, UK. At a luncheon, and at a subsequent lecture in the Recording Hall of the Sydney Opera House, Raymond Cooke talked about the technical research which is behind the production of KEF loudspeaker systems.



Mr Raymond Cooke, Managing Director of KEF Electronics Ltd, U.K.

Coming from an engineering background, Raymond Cooke is well qualified to talk about loudspeaker systems at this level. Without having been around the hifi scene for quite as long as some of the pioneers like Gilbert Briggs, his career and theirs have nevertheless overlapped, and he is able to adopt the posture of a pioneer without suffering the limitation of too many passing years. He is, in fact, still in his forties.

Originally, Raymond Cooke had no idea of becoming involved in electronics. By birth a Yorkshireman, he trained as an analytical chemist and pursued this role in the thoroughly traditional and British environment of the London and North-Eastern Railway Company.

With the outbreak of war, having no personal fancy for the infantry, he joined the Fleet Air Arm as a radio and radar mechanic. And it was there that the professional man of chemistry found a new and absorbing interest.

After the war, Raymond Cooke took up electrical engineering in earnest at the London University, gaining a BSc degree with Honours. His first job in the electronics industry was with the Mullard Radio Valve Company, as a production engineer concerned with picture tubes.

But even picture tube technology, with its unique combination of electronics and chemistry, did not provide the right incentives and, in due course, Raymond Cooke moved into the Recording Systems Department of the BBC, and later into Wharfedale Wireless Works Ltd, in association with Gilbert Briggs.

Over lunch, Raymond Cooke explained how this last move came about. As an avid reader of audio articles and textbooks, he gradually reached the conclusion that Gilbert Briggs had arrived at certain acceptable conclusions — for the wrong reasons! Rather diffidently, he expressed this conviction to the famous GAB and waited for the expected explosion.

But there was no explosion. Instead, Briggs offered him a job at Wharfedale and also invited him to rewrite the contentious material. So it was that Raymond Cooke became Technical Director of Wharfedale and Technical Editor of the Briggs series of audio textbooks. To quote the whimsical Briggs, from one such book:

"We now have what I look upon as an ideal arrangement — he does all the work and I take most of the credit!"

In 1961, Cooke decided to branch out on his own and founded KEF Electronics in an old Nissen-type hut at Maidstone. The first couple of years were a real struggle but then the tide turned and KEF forged ahead, culminating in the Queen's Award to Industry in 1970, and also the BNEC Export Award for smaller firms.

Now, in 1974, the three letters KEF (which curiously and originally stood for Kent Engineering Foundry) are known around the world, partly because of Raymond Cooke's own globetrotting activities, and partly because of on-the-spot representation — as by Audioson Pty Ltd, in Australia.

At the lecture in the Recording Hall of Sydney's Opera House, Raymond Cooke indicated that one of the main thrusts in the KEF research program was to try to identify the reason why loudspeaker systems, which exhibit similar response

curves, can sound so different on program material.

He remarked that KEF Laboratories are taking the "policeman's approach" to the problem, as distinct from that of a fictional detective, who "looks in the ashtray, pauses for a few telling moments, then points unerringly at the guilty party". The real life research worker, like the real life policeman, usually has to sift through a tedious mass of evidence, hoping for some kind of a pattern to emerge.

One line of investigation which KEF Laboratories have been following, has to do with the behaviour of a loudspeaker system immediately after having been excited by a signal transient.

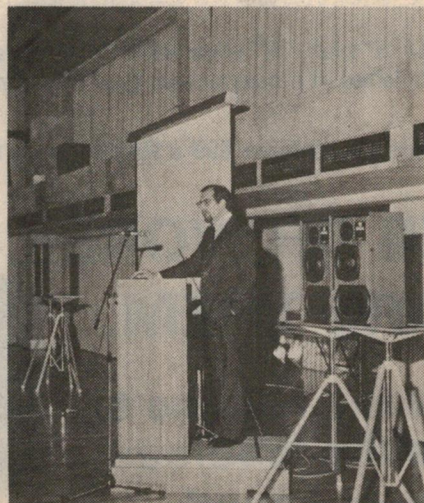
The problem is fairly well known in the context of complete enclosures, particularly in the lower register. For a variety of reasons, enclosures add their own resonance "boom" to a transient, in addition to which reflections from the inside faces may issue through the cone, which forms a relatively sound-transparent window in the front baffle.

But, over and above the enclosure, subtle effects can be attributed to the loudspeaker itself, which may account for some of the mysterious "Colouration" which is evident to the ear.

When a burst of drive signal is applied to a loudspeaker, the acoustic output does not necessarily have the same "envelope" pattern as the drive signal. There is normally some overshoot or "hang", which produces an acoustic output beyond, and additional to, that during the driven period. This is integrated by the ear to become part of the total perceived sound and it is reasonable to assume that it can be responsible for some colouration.

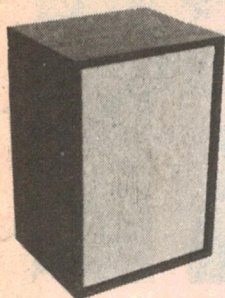
Normal frequency runs, which supply and measure a progression of steady tones, produce a "steady-state" response curve, substantially ignoring transient behaviour of the moving system.

Raymond Cooke said that early efforts to isolate, identify and measure the post-drive behaviour of a loudspeaker were extremely tedious, time-consuming and unprecise. More than that, it was not possible to isolate and examine the behaviour and output of the moving system less than 2 milliseconds after the cessation of drive.

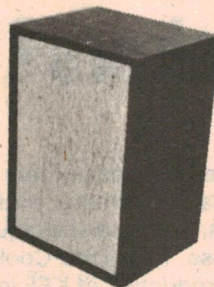


Mr. Cooke on the rostrum in the Recording Hall of the Sydney Opera House. Two pairs of KEF model 104 "Reference Series" domestic systems were necessary to cope with the room which, although one of the minor halls, is in fact quite a large area.

jensen



MODEL 1



**"GREAT
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(or any stereo system)**

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2

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4

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AUSTRALIAN DISTRIBUTORS:

BJD

Electronics Pty. Ltd.

202 Pelham St., Carlton, 3053 Vic. Ph. 347-8255.

190 Willoughby Road, Crows Nest, 2065 N.S.W. Ph. 439-4201

All these limitations have recently been overcome by more sophisticated testing procedures and by resource to computer analysis.

The loudspeaker under test is now fed with a train of very narrow rectangular pulses, which can be accurately defined — and repeated — in terms of rise time, duration, amplitude and repetition rate. Theoretically, a rectangular pulse has frequency components extending from zero to infinity and therefore includes all frequencies likely to be fed to the reproducer.

The resulting output from the loudspeaker under test is picked up by a miniature microphone and fed to a recorder for subsequent analysis, the quality of this equipment being such that the true transient, frequency and phase characteristics of the loudspeaker are substantially represented.

The procedure which follows rests on the premise that a great deal can be deduced about the frequency and phase characteristics of a system — any system — by detailed analysis of the way it copes with a rectangular input pulse. Nowadays, such analysis is most obviously performed by computer.

By means of a slide, Raymond Cooke showed a whole family of curves for a typical reproducer, showing its output across the audio spectrum at intervals during the die-away period. Drawn for intervals a specific number of microseconds apart, all the data fell well inside the previous minimum limit of 2 milliseconds.

It was very revealing.

Coinciding with the end of the drive period, the output across the spectrum was substantially level — the kind of curve one would expect from a high quality unit. And it would almost certainly be the kind of curve one would get from a conventional continuous tone test.

Immediately following cessation of the pulse, but with the system still in motion, output across the spectrum in the next curve was noticeably less level, with the first hint of peaks and troughs.

These were seen to develop in the succeeding curves, so that the output at the end of the measured period had developed very noticeable peaks and troughs. It seemed reasonable to speculate that the presence of this "hang" or "die-away" output, plus its frequency conscious nature, could colour the total sound as heard by the ear.

But here Raymond Cooke referred again to the "policeman's approach" to a problem.

It would be easy to look at the said family of curves and to assert that the culprit had been identified.

More realistically, it will be necessary to examine the post-drive behaviour of many loudspeakers to see whether a relationship can be established between what the curves show and what the ear perceives. If no such relationship can be established, it may be necessary to go back to the scene of the crime and start again!

A point which emerges from all this, and not specifically mentioned by Mr Cooke, has to do with the nature of typical program material and the degree to which it may contain transients able to expose the post-drive characteristics. Some material may contain very few transients and may therefore not give rise to post-drive colouration; with highly percussive

KEF's NEW "REFERENCE" LOUDSPEAKERS

Already doing very well with their existing range of loudspeakers, KEF Electronics Ltd have announced a completely new range which will be known as the "Reference Series". The emphasis, it seems, will be on providing ultimate quality in the home situation, rather than achieving a competitive price level.

The first of the new series to reach Australia is model 104, pictured on the right. Four of them were flown in especially for the Raymond Cooke lectures in Sydney, Melbourne, Adelaide and Perth.

Model 104 has overall dimensions 630 x 330 x 260 mm, or roughly 24 x 12 x 10 inches. As such, it can be used as a free-standing unit, or placed on a reasonably substantial shelf.

It can be regarded as a two-speaker or three-speaker system, depending on the point of view. The main drive unit has a nominal diameter of 200 mm, with Bextrene diaphragm, a drive system which will remain unaffected by any likely temperature rise, and a fundamental resonance of 25Hz.

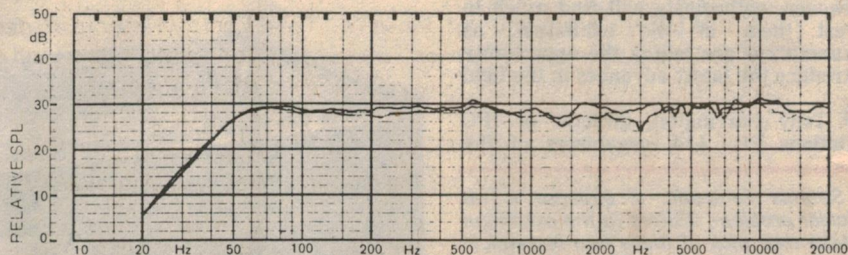
It operates in what is basically a reflex enclosure but the port space is occupied by a large passive radiator which has in fact been derived from the KEF B139 bass driver. Because of acoustic coupling to the main driver, this passive radiator provides most of the output below 45Hz. The nominal frequency range extends downwards to 30Hz.

The main 200 mm driver handles frequencies up to 3000Hz, beyond which Milinex domed tweeter takes over.



The model 104 is designed to operate in conjunction with amplifiers of RMS rating between 15 and 50 watts per channel into 8 ohms.

Optional finishes are walnut, teak and white, while the grille (not shown) is of black microcellular foam. (Details from Audioson International Pty Ltd, P.O. Box 3611, Brookvale NSW 2100; or at 64 Winbourne Rd, Brookvale, NSW.)



material, on the other hand, colouration may be difficult to recognise as such.

But it's interesting material for debate.

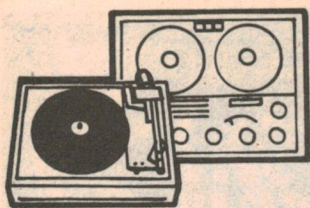
Outside the main stream of discussion, Mr Cooke had mentioned that KEF produced special monitor loudspeakers for the BBC. This led to a question from the audience as to the difference between a monitor loudspeaker and a high quality domestic system which may be of generally similar appearance and specification.

Mr Cooke replied that the description "monitor" was tending to be used too freely and was losing its proper connotation. A monitor loudspeaker normally has to conform to the particular customer's requirements and it may or may not be optimum for average domestic use.

A true monitor loudspeaker had to be designed with more than the usual em-

phasis on ruggedness and reliability, since it will most likely be used at higher power levels and for longer periods than in the domestic situation. The latest generation of monitor loudspeakers, in fact, often contained their own in-built power amplifiers with electronic overload circuitry designed to protect the system from undue or accidental overloads.

Supplying monitor loudspeakers to an organisation like the BBC might be good for prestige, Mr Cooke suggested, but it was not necessarily a way to grow rich! While the unit price of monitor loudspeakers was high, it had to cover the cost of limited production, very tight quality control, individual calibration to tight specifications and the ability to service and maintain calibration — not necessarily in the most convenient circumstances.



Hi Fi News

'75 Sounds Fantastic . . . everything with a minimum of mystique!

Following the awareness of the high fidelity industry that technical terms and language scare off a significant percentage of potential customers, the keynote of '75 Sounds Fantastic — a high fidelity exhibition to be held at Centrepont, Sydney, from August 13 to 17 this year — is the simplicity and beauty of quality high fidelity sound reproduction.

The exhibition is designed to offer the general public a wide range of equipment, advice, and some appreciation of its performance.

Most of the leading manufacturers in the high fidelity field will be displaying their new ranges of equipment and a sound theatre, in which programs encompassing the entire spectrum of musical experience from chamber music to pop will be demonstrated, has been arranged. Visitors to the exhibition will be able to see, hear and compare equipment from all over the world.

Market potential in Australia in this field is enormous for present and future sales and '75 Sounds Fantastic is planned to take hi fi out of its "ivory tower" and into the homes of people who formerly considered it too complex a subject.

However, enthusiasts will find much to interest them at the exhibition, as manufacturers are taking the opportunity to introduce the latest advances in the field also.

Mr Tony Farrington, director of IPC Exhibitions Pty. Ltd, organisers of the

'75 Sounds Fantastic: If expense is no particular problem, visitors to the exhibition can take their pick of these two Nakamichi players, representing just about the ultimate in cassette equipment. Both employ three separate heads — erase, record and replay — allowing tapes to be monitored as they are recorded. The Nakamichi 700 "Tri-Tracer", illustrated at the top, is styled to suit the domestic situation and can be integrated into a home music system in the same manner and with a performance comparable with high quality open reel machines. It has input mixing facilities, specifications of the highest order and solenoid control facilities giving not only smooth control but operating in a sequence to eliminate clicks from the completed tape. The Nakamichi 1000 Tri-Tracer, below, is the top of the line model, professionally styled and intended for professional as well of de-luxe domestic installations. The Nagamichi machines will be exhibited, along with many other items, by Magnecord, 276 Castlereagh St, Sydney 2000.



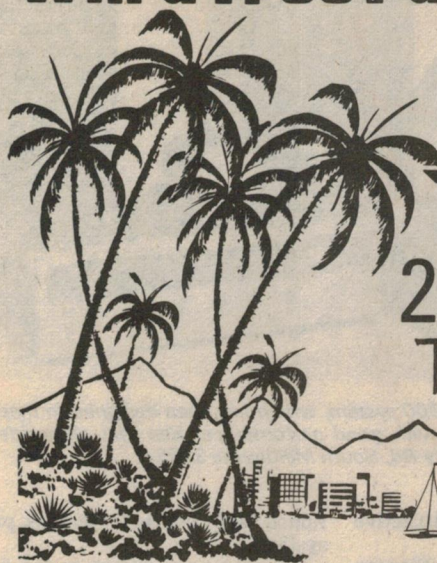
exhibition, stated recently that industry support is considerable for '75 Sounds Fantastic and 70% of available space was booked out within two weeks of the exhibition's launching.

Broadcasting Station 2GB will conduct a major promotion in conjunction with the exhibition with planned maximum listener involvement. Jeremy Cordeaux's midday session will be broadcast from Centrepont daily from Tuesday, August 13 to Friday, August 16.

Arrangements are being completed for the 2GB "live" broadcast booth and also a display of imaginative crystal radio sets constructed by 2GB listeners.

Originally the station's own "brainchild", the crystal set competition came to the notice of "Electronics Australia" when

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PUZZLE CLUES.

SANSUI AUTOMATIC RETURN TURNTABLE SR 212

Budget-minded and a winner this new automatic turntable is not only made of carefully-chosen precision components, but it has been designed with particular emphasis on ease of operation, reliability and tonal quality.



SANSUI SPEAKER SYSTEM SP 65

A 2-Way wide dispersion, acoustic suspension, 40 Watts. Convenient size, with rich and clear sound, smooth transient response, handsome open-pore walnut finish and air tight enclosure distinguish this advanced speaker system.

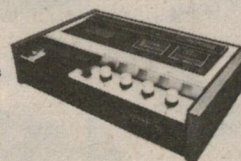


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SANSUI "DOLBY SYSTEM" STEREO CASSETTE DECK SC 737

Reel-to-Reel quality with cassette convenience. Features include high-density magnicrystal ferrite record/Play Head, Record/Play back Preamplifier Tape selection switch and peak level indicator and professional VU Meters.



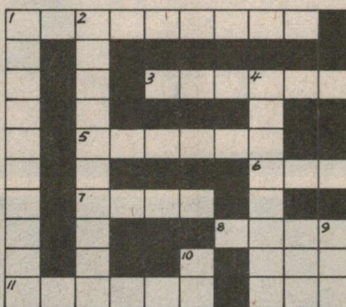
SIMPLY COMPLETE AND RETURN THIS CROSS-WORD ENTRY FORM WITH YOUR COMMENTS — IT COULD BE YOUR FREE PASS TO PARADISE.

CLUES ACROSS:

- Opposite of Manual.
- This Hi Fi Company could send you on a Noumea Holiday.
- An Amplifier control that accentuates stringed instruments.
- Abbreviation for an input socket.
- The Deepest sound.
- A basic part of tapes or fishing rods.
- Sansui offer a complete Hi-Fi

CLUES DOWN:

- These Sansui components are both solid state and integrated.
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- They produce the sound and enhance your room.
- Sansui amplifiers have this Degree of noise level.
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Conditions of Entry

- Closing date 29th September, 1974 — Winners notified by mail within 3 weeks after closing date.
- Chance plays no part in determining prize winners.
- Judges' decisions are final and no correspondence will be entered into. Entries will be judged on accuracy and neatness.
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Brisbane Office: 14 Proe Street, Fortitude Valley, Qld. Tel. 52 7333.
Perth Office: 27 Oxford St., Leederville, W.A. Tel. 81 4988.

HIFI NEWS

2GB's Frank Vowls rang E.A. Editor-in-chief to compare notes on how such a competition could be run. From this came the idea that "Electronics Australia" might like to publish details of selected entries, with a credit line to 2GB and a publication fee to the competitor. All the station needed now was a sponsor and Reg Hall of Kenwood was ready to admit that a crystal set competition sponsored over the air and exposed in an exhibition, looked like a pretty good novelty promotion. So it became the Kenwood / 2GB crystal set competition, with "Electronics Australia" in a back-up role.

The High Fidelity Industry Association, which is sponsoring the exhibition, is composed of suppliers of high fidelity audio equipment in Australia.

The equipment to be displayed ranges from some of the most costly and exotic anywhere in the world to systems which combine economy with an order of performance likely to satisfy a great many initiates to the realm of high fidelity. Some of the budget level systems are made up from items selected from different makers; others, like the new Rondo 3000, are one-brand systems.

Concerning the Rondo 3000, Doug Bell of Pioneer has this to say:

"Rondo 3000 is Pioneer's latest offering to the system buyer. For the person that wants good quality sound, versatility of components and the simplicity of a system



'75 Sounds Fantastic: The Rondo 3000 system, which has been designed to meet the need for a system combining economy with good performance. See text alongside. (Pioneer Electronics Aust. Pty. Ltd., 256-8 City Rd, South Melbourne 3205.)

purchase, Rondo 3000 is a very attractive 'package'.

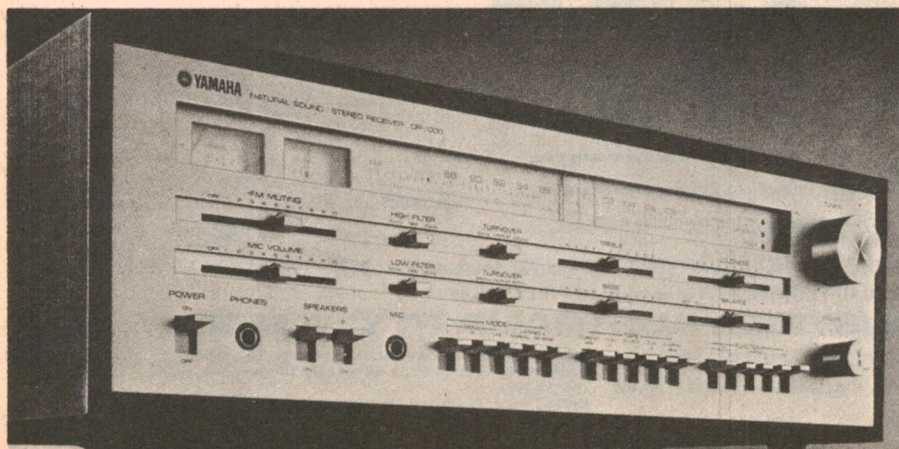
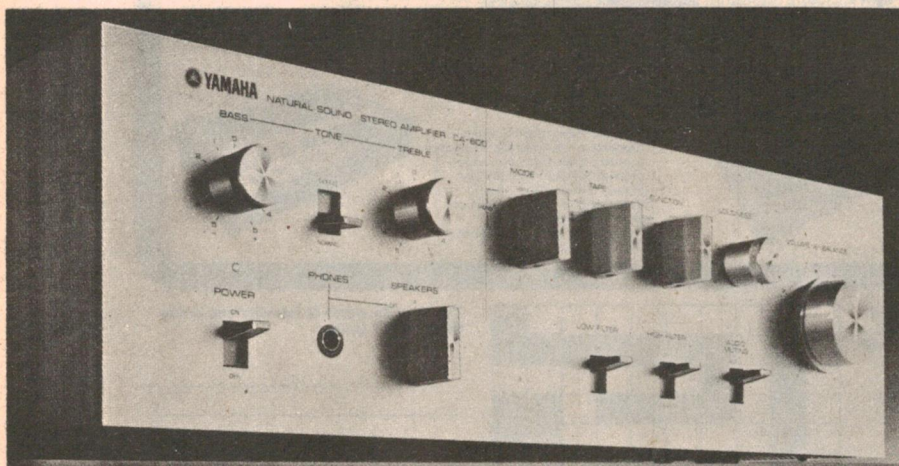
"The units that make up the Pioneer Rondo system are a belt drive turntable; tuner amplifier with AM and FM plus two quadraphonic matrix circuits (RM and SQ), a 3-way 3-speaker system and a pair of stereo headphones. Everything to satisfy most needs, and all compatible. The headphones are a particularly interesting feature. More and more people are using headphones as an accessory but, with

Rondo 3000, you get them as part of the system.

"Pioneer have an eye on the future with the inclusion of an FM tuner, and the quadraphonic circuits — all the buyer needs is a second pair of speakers to obtain 4-channel sound. Another feature is the matching Rosewood cabinet that is available from Pioneer dealers as an option. It solves that 'where to put the hi-fi' problem for the first-time buyers.

"To anyone with \$400 to \$500 to spend on hi fi, the Pioneer Rondo 3000 is a complete, compatible system well worth listening to. Recommended retail price is \$459 and the Pioneer 1-2-3 year full warranty applies."

Incidentally, the Sydney branch of Pioneer has moved into a new office / warehouse in Brookvale. The building provides over 12,000 square feet of space

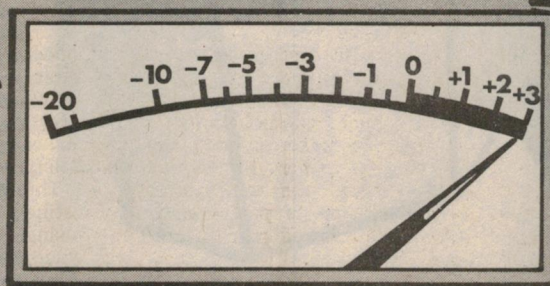


'75 Sounds Fantastic: Yamaha products will be featured prominently by Rose Music Pty Ltd, of 17-33 Market St, South Melbourne. At the top is the CA600 stereo integrated amplifier, which is rated at 32W RMS per channel at 1kHz into 8 ohms and 40W into 4 ohms, with both channels driven. Power bandwidth over the audio spectrum is very wide and rated harmonic distortion is below 0.1pc overall at full rated power. Full control facilities are provided, with input facilities for two phono, two auxiliary, radio tuner, microphone and tape system. There is provision also for two sets of loudspeakers. The CR1000, at the bottom, is a complete high-performance stereo receiver / amplifier. In the latter role, it has all the input, output and control facilities that one could possibly need and, for good measure, an RMS power rating of 75W RMS per channel into 8 ohms (100W into 4 ohms) with both channels driven. The radio facility is a high performance FM / stereo tuner but curiously, in a unit which boasts so many other facilities, there is no mention of an AM tuner. Rose Music will also be displaying Yamaha loudspeaker systems which seem to have shed their one-time and rather pointless links with Yamaha organ practice. The latest series have received wide acceptance overseas.

The Acid Test.

"Hey!
Watch out!
The needle's right
over into the red!"

"Relax...
I'm using a
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VIC. B.J.D. ELECTRONICS
202 Pelham Street,
Carlton, Vic. 3053

LERO 56

HIFI NEWS

and all sales, service and despatch is located at the new address — 20 West Street, Brookvale. The new phone number is 93 0246. A new demonstration centre is planned for the new location for the convenience of customers and dealers.

Rank Industries Australia Pty Ltd will have three complete stands in the main exhibition area. They will be displaying a wide range of products carrying names known worldwide in the context of high fidelity sound reproduction. Included are: Sansui, Wharfedale, Leak, Thorens, Ortofon, Altec, Tandberg, Ampex, Watts, Silcron, Grayson.

In detail, the ranges include:

Sansui — complete range of all products —



'75 Sounds Fantastic: Whatever other amplifiers there may be at the exhibition, it is unlikely that many of them will have the sheer power of this Bose 1801 unit, intended for use with a separate pre-amp control unit. With other characteristics which fall well inside limits which the manufacturer considers adequate, the 1801 will deliver 150W RMS per channel into 16-ohm loads, 270W into 8-ohm loads and a whopping 440W into 4-ohm loads! On the left is another item from the Wedderspoon catalog, the AR-LST loudspeaker system by Acoustic Research. Designed for professional or high level domestic use, the AR-LST (Laboratory Standard Transducer) is basically a larger, higher-powered counterpart of the company's popular AR-3 series. (From W. C. Wedderspoon Pty Ltd, 3 Ford St, Greenacre, NSW).

amplifiers, tuners, turntables, speakers, headphones and tape decks.

Wharfedale — Denton 2, Linton 2, Melton 2, Dovedale 3 (all speaker systems), DC 9 tape deck, DDi headphones.

Leak — 200, 300 and 600 speaker systems and Delta 70 amplifier.

Thorens — TD165, TD160C, TD125 turntables.

Silcron — MK2 and MK4 turntables.

Grayson — TU1 and TU2 turntables.

Watts — Dustbug, Discpreener, Manual Parastat, Hi Fi Parastat record cleaning accessories.

Tandberg — new 9200X, 3400X and TCD310 professional tape recording equipment.

Altec — complete range of Altec Lansing consumer and professional hi fi speaker systems.

Ortofon — M15E Super, M15 Super, FF15 and FF15E magnetic pickup cartridges.

Ampex — high quality American cassette and reel recording tape and accessories.

Other exhibitors, not mentioned elsewhere in the text, include the following: Arena Distributors A'Asia Pty Ltd, 273 Hay St, Perth, WA, 6000.

Auriema A'Asia Pty Ltd, 15 Orchard St, Brookvale, NSW, 2100.

Australian Musical Industries, 155 Gladstone St, Sth. Melbourne, Vic, 3205.

R. H. Cunningham Pty Ltd, 493-7 Victoria St, West Melbourne, Vic, 3003.

Deitron International, 51 Kyle Parade, Kyle Bay, NSW, 2221.

Haco Distributing Agencies, 57 Anzac Parade, Kensington, NSW, 2033.

Hagemeyer (Aust) N.V., 57 Anzac Parade, Kensington, NSW, 2033.

Jacoby Mitchell Ltd, P.O. Box 2009, North Parramatta, NSW, 2151.

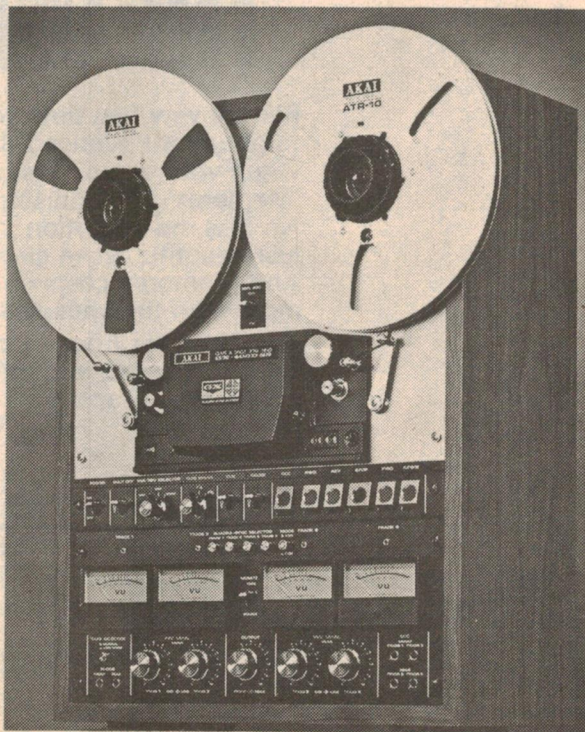
Jervis Australia Pty Ltd, 1/111 Old Pittwater Rd, Brookvale, NSW, 2100.

Kitsets Australia, 21 Oaks Avenue, Dee Why, NSW, 2099.

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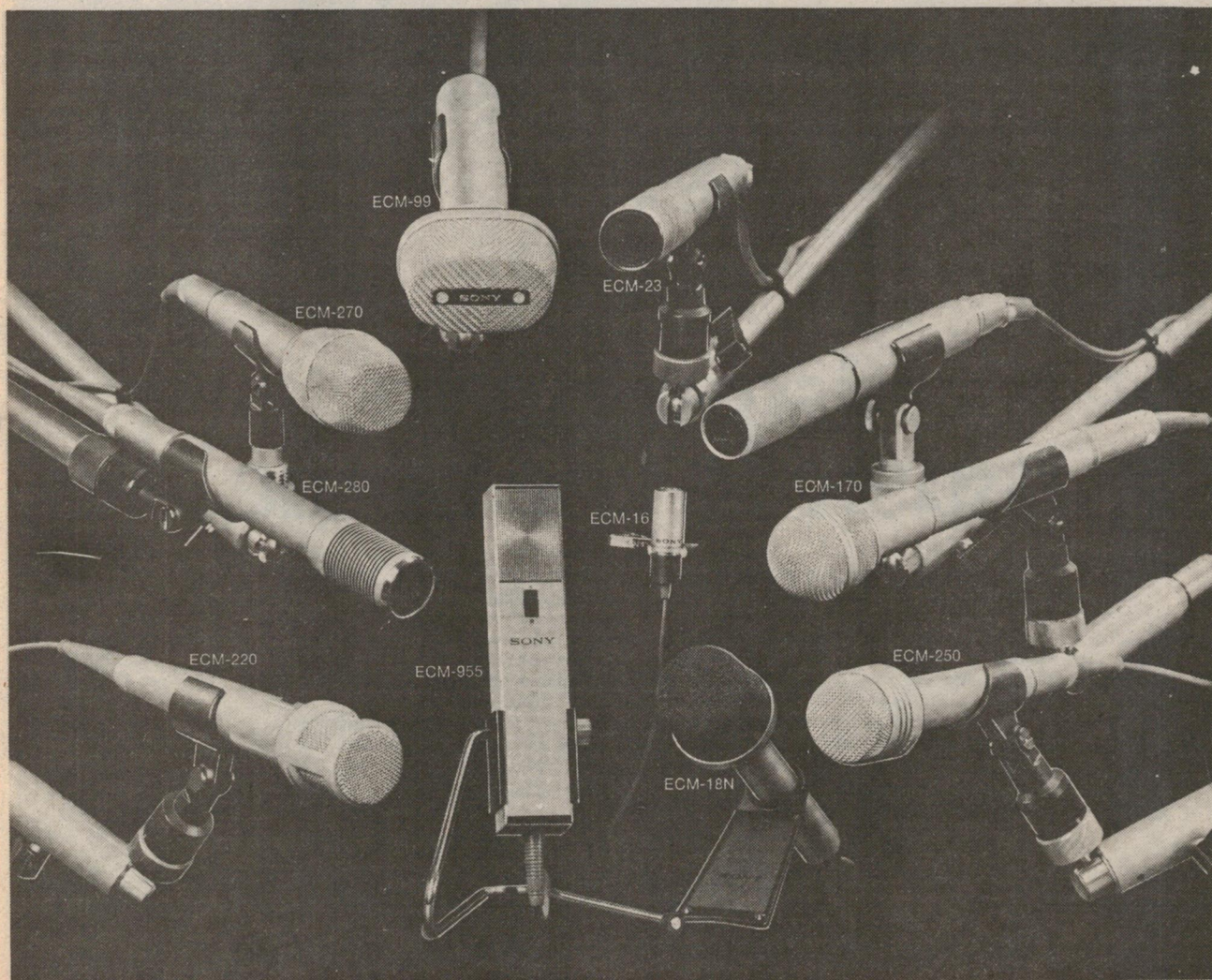
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Output Impedance (100 Hz)	250 Ohms unbalanced	250 Ohms unbalanced	250 Ohms balanced	200 Ohms balanced	200 Ohms balanced	200 Ohms balanced	200 Ohms unbalanced	200/10K Ohms unbalanced	250 Ohms unbalanced	1,500 Ohms $\pm 20\%$
Output level (0dB = 1 V/10 μ bar)	-56.8 dB	-57.8 dB	-56.0 dB -64.0 dB (w/ pad)	-56.0 dB	-57.0 dB	-56.0 dB	-57.0 dB	-58/-41 dB	-56.8 dB	-54 dB
Signal-to-noise ratio (1000 Hz 10 μ bar)	Better than 60 dB	Better than 66 dB	Better than 66 dB	Better than 64 dB	Better than 66 dB	Better than 64 dB	Better than 66 dB	Better than 64 dB	Better than 60 dB	Better than 60 dB
Inherent noise	Less than 34 dB SPL	Less than 28 dB SPL	Less than 28 dB SPL	Less than 30 dB SPL	Less than 28 dB SPL	Less than 30 dB SPL	Less than 28 dB SPL	Less than 30 dB SPL	Less than 34 dB SPL	Less than 34 dB SPL
Wind noise	Less than 45 dB SPL	Less than 50 dB SPL	Less than 45 dB SPL	Less than 50 dB SPL	Less than 50 dB SPL	Less than 40 dB SPL	Less than 50 dB SPL	Less than 50 dB SPL	Less than 35 dB SPL	Less than 48 dB SPL
Maximum sound pressure level	126 dB SPL	126 dB SPL	130 dB SPL	128 dB SPL	126 dB SPL	126 dB SPL	126 dB SPL	126 dB SPL	126 dB SPL	122 dB SPL
Dynamic range	92 dB	98 dB	102 dB	98 dB	98 dB	96 dB	98 dB	96 dB	92 dB	88 dB
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Broadcasting in Stereo

While the FM broadcasting system has much to commend it in its original monophonic form, its appeal to listeners interested in high quality reception has been vastly increased by the incorporation of a stereo facility. This article explains how stereo signals are imposed on the one basic FM carrier, and how they are separated out again in the receiver.

by NEVILLE WILLIAMS

In the late 1950's, with the emergence of two-channel stereo tape and disc systems, there was naturally a good deal of speculation about the possibility of stereo broadcasting.

The speculation and interest was world-wide and included suggestions for modulating AM transmitters with non-symmetrical sidebands, or using pairs of existing transmitters to radiate respectively the left and right stereo signals. In Australia, the latter scheme was taken up by a few stations, usually for late-evening stereo music. To reproduce the program in the home, it was necessary to use two receivers suitably placed in the listening room.

While such ventures were interesting enough at the time, they were necessarily short lived. The programs monopolised two stations and doubled the spectrum space required for any given program. There were obvious difficulties, also, in maintaining a suitable phase and amplitude balance between the stereo signals both at the transmitting and the receiving end.

Clearly an integrated system was required, and far and away the best chance of evolving one related to the then relatively new FM system, with its emphasis on quality reproduction, and the generous spectrum space allocated to each channel. Not surprisingly, USA, the birthplace of FM broadcasting, also became the birthplace of the FM / stereo system.

Quite early the FCC, as the administrative authority in the USA, had made known its strong bias towards compatibility. Its objective was to discover, test and promulgate a stereo system that would not render obsolete existing monophonic FM transmitters and receivers. Stereo transmitters should provide a satisfactory mono signal for existing receivers, while mono transmissions should be resolved as such by stereo receivers.

More than that, the stereo signal should conform to the bandwidth limitations already imposed on monophonic FM broadcasting.

No less than seventeen possible methods were submitted for evaluation to the National Stereophonic Radio Committee, an industry group working in association with the FCC. These were narrowed to eight systems, representing six distinct approaches to the problem.

During the latter part of 1960, the methods

were air-tested using the facilities of KDKA Pittsburgh and the results wound up as a voluminous report to the FCC described as being "as bulky as two New York City Telephone directories".

After studying these reports, the FCC issued standard specifications for a stereo FM system in April 1961, modelled mainly on proposals originally put forward by the General Electric Company and by Zenith Radio Corporation. With minor variations it has been adopted as a world standard.

This system solves the compatibility problem in the most obvious manner. The left and right signals of the stereo pair are effectively added — e.g., matrixed to form a "sum" signal — and used to modulate the FM transmitter in the usual manner. A conventional mono FM receiver, tuned to the station, produces an apparently normal mono program, with a frequency response to 15kHz.

A listener using such a receiver, whether it be a dated model or a new mono portable, need not be aware that the station is involved in anything technically more ambitious.

The procedure assumes that the program material is itself stereo / mono compatible. This is usually the case with stereo discs and tapes, which are normally designed to produce an acceptable signal when played in the home on a mono rather than a stereo reproducer.

There is one reservation, however. When an FM station is transmitting mono only,

the modulation level can be set so that the carrier is deviated to its full permitted limit on signal peaks. Receivers can obviously recover the maximum amount of audio from the transmitted signal, ensuring the best possible signal / noise ratio.

If the station has to transmit information additional to the mono or sum signal, it is reasonable to expect that the mono signal may have to be reduced somewhat, if the station is to stay within the original deviation limits. As a result, the audio recovered by a mono receiver may be proportionately less, with a consequent reduction in the signal / noise ratio.

And this, in fact, is what happens. An FM transmitter handling a stereo signal does have to cope with additional information, of a form yet to be discussed. Presence of this extra information makes it necessary to depress the level of the mono signal so that its peaks under any conditions are not more than what would otherwise represent 90pc modulation. In practice, at the receiving end, it usually ends up in about a 4dB drop in recovered audio. In a strong signal area this would not be noticed but, in a marginal situation, it could represent some degradation in the signal recovered by a mono receiver.

In itself, it is a comparatively small price to pay. Much more to the point is the signal / noise ratio of audio recovered in full stereo mode, and this will emerge later in the discussion.

Having provided all receivers with a

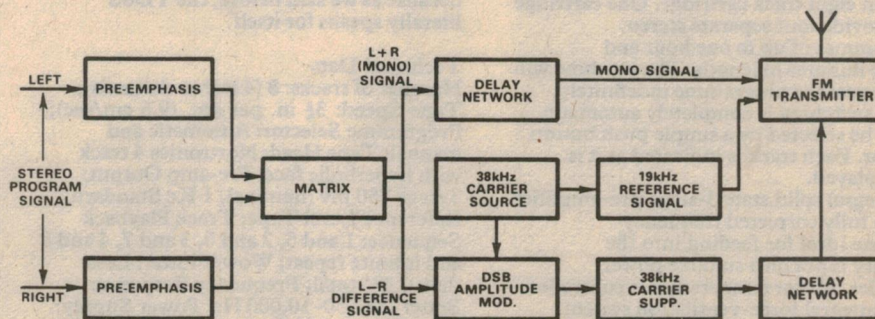
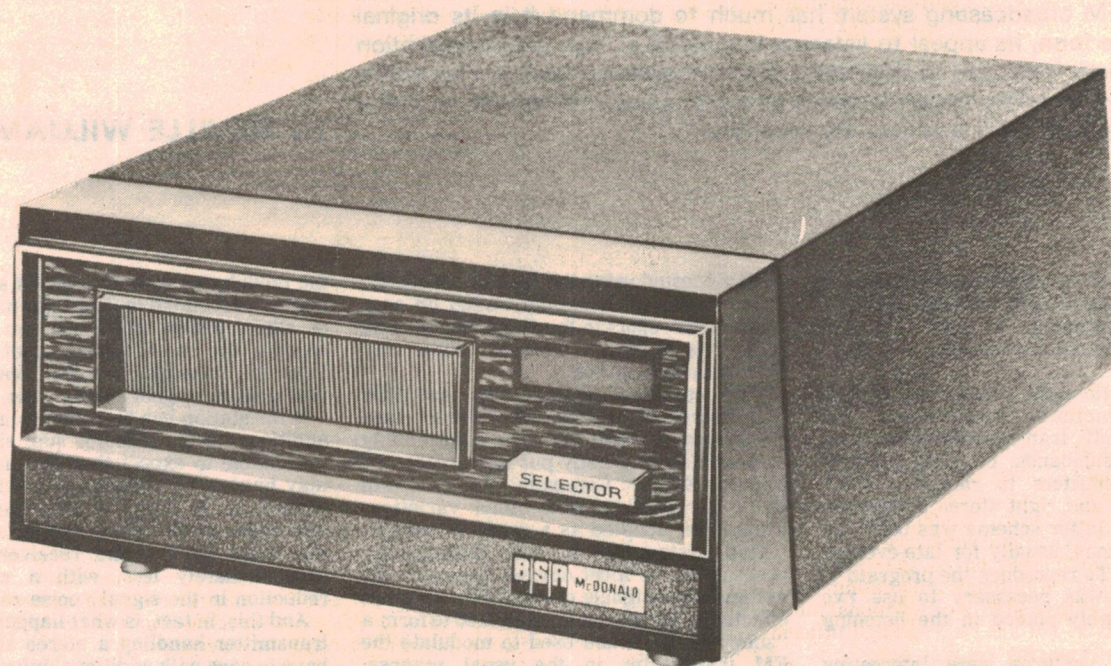


FIG. 1

This block schematic diagram shows how the stereo signal pair is processed for ultimate transmission through what would otherwise be a normal VHF FM transmitter. In America, FM transmitters are commonly fed with an additional 67kHz sub-carrier on which is superimposed an entirely separate program for background music in local stores, etc. This has nothing to do with stereo broadcasting as such and is not shown in the diagram.

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FM-STEREO

mono or L-plus-R or "sum" signal, and having thus achieved compatibility, the system must now provide a second signal for stereo receivers, so that they can reconstruct the original stereo pair. What they require, not surprisingly, is a "difference" or L-minus-R signal.

By ultimately combining the sum and difference signals in a suitable amplitude and phase relationship, the original L and R components can be recovered and made available to the left and right channels of the stereo amplifier.

The algebra, at least, is very simple.

To recover the L(left) signal, the sum and difference components can be added directly:

$$(L + R) + (L - R) \cdot 2L$$

To recover the R (right) signal, the phase of the difference signal is reversed prior to adding in a separate network:

$$(L + R) - (L - R) \cdot 2R$$

The real problem which faced engineers around 1960 was how to impose the necessary "difference" signal on the FM carrier, in such a way that it could be intercepted and resolved by a suitably designed receiver, without producing any unwanted effects in mono receivers.

In an article presented at this level, it is conventional to suggest that the difference signal is derived by matrixing, then imposed on a supersonic sub-carrier which, in turn, is modulated on to the main FM carrier. The additional modulation components are ignored by a conventional mono FM receiver, but are resolved and utilised by stereo receiving equipment.

In fact, it can be shown that a quite different concept produces much the same end result. This visualises a time multiplex system which samples the left and right components at a supersonic rate. If this switched sample is filtered to remove all harmonics other than the fundamental (to avoid excessive deviation) and then frequency modulated on to the carrier, the end result becomes virtually equivalent to a subcarrier at the switching frequency modulated by the difference signal.

The foregoing paragraph is perhaps more general than precise but it does give the clue to subtleties behind the usual explanation. It also leaves open the way to approaches at the receiving end which relate more to time division techniques than to normal detection.

Fig. 1 is the conventional block diagram of the so-called stereo multiplex system, which shows the progress of stereo program signals through to the aerial of an FM transmitter.

The stereo signal pair to be fed to the transmitter are shown entering the block diagram from the left. They first pass through individual pre-emphasis networks, which boost the treble by the customary amount: 50uS or 10dB at 10kHz for the European standard; 75uS or 15dB at 10kHz for the original US standard.

From the pre-emphasis networks, the stereo pair enter a combining or matrix system. With the levels and phasing under close scrutiny, the signals are added in phase to produce a sum or mono component. This is equivalent to what one would get by playing stereo record with a mono pickup, or a stereo cassette through a mono player.

In another branch of the matrix circuitry, one channel is reversed in phase by 180 degrees then combined with the other channel to produce what is, in effect a difference component. (You may recall the old axiom: "to subtract a quantity, reverse its sign and proceed as in addition!")

The mono signal is fed to a delay network and thence to the modulating circuits of what could well be a conventional FM transmitter. Purpose of the delay network is to provide a means whereby the phase of the sum signal can be correctly related to that of the difference signal, the latter being subject to a good deal more processing on its way to the modulating circuits.

This detail aside, the upper portion of the diagram provides the mono FM program, which is the basis for mono/stereo compatibility.

Looking now at the difference signal, this is amplitude modulated on to a supersonic carrier, as previously mentioned. This carrier is at 38kHz, plus or minus a couple of Hz. Assuming that the difference signal will contain frequency components to 15kHz, the output from this modulator will contain a 38kHz carrier, plus sidebands extending from 23kHz to 53kHz.

In fact, the actual 38kHz carrier is suppressed at this point to not more than 1pc of its normal amplitude — and with good reason. If it were retained at normal am-

tend to be complementary. When the left and right channel information adds to produce the largest sum signal, and therefore the heaviest basic modulation of the FM carrier, at this same instant the difference signal and its contribution is at a minimum. The converse is true.

As a result, inclusion of the difference information has little effect on the amount of sum (or mono) modulation which can be applied.

However, if the difference signal is to be correctly resolved by receivers, they must be able to replace the suppressed sub-carrier with a locally generated signal of precisely the right frequency and phase.

To enable this to be done conveniently, one other component is added to the transmitted signal: a 19kHz reference or "pilot" signal, precisely half the frequency of the suppressed carrier and phase locked to it. This relationship can be established at the transmitter either by generating a precise 38kHz carrier and halving it to produce the reference frequency, or vice versa. At the receiver, the reference frequency, is separated out and used to phase lock a 38kHz source, thus effectively regenerating the missing carrier.

But why suppress one carrier from the transmission, only to replace it by another?

The answer lies largely in the fact that the 19kHz reference (or pilot) signal is at a

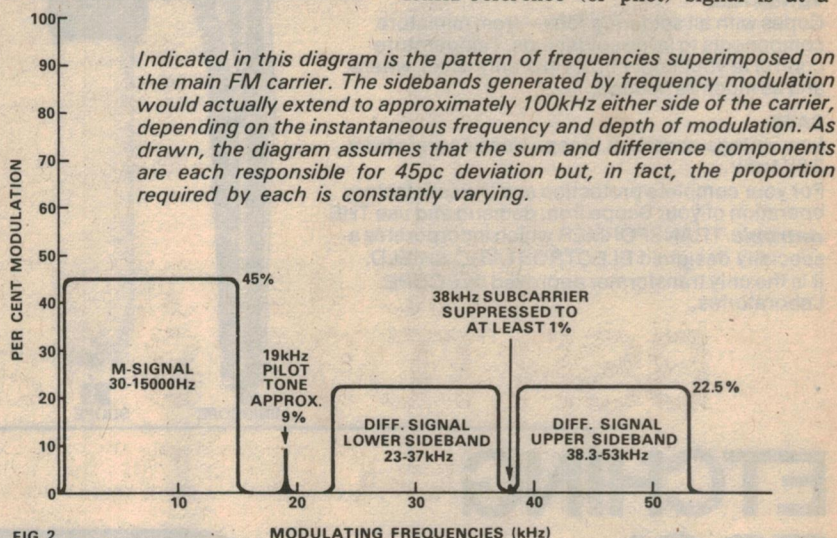


FIG. 2

MODULATING FREQUENCIES (kHz)

plitude and subsequently applied to the main FM carrier, it would add substantially to the deviation, without contributing proportionally to the essential signal information. In fact, the sub-carrier would be at its maximum amplitude during those instants when there was no difference information to convey!

With the 38kHz carrier suppressed, the difference signal assumes the form: double-sideband, suppressed carrier, abbreviated frequently — but not very accurately — to the letters DSB. The full abbreviation should be DSB-SC.

This DSB-SC signal also passes through a delay network to permit fine adjustment of the phase, and then on to the main modulator, where it, too, is imposed on the main carrier as a frequency modulation.

Fairly obviously, when the difference signal is at a minimum, so also are the related sidebands; in the absence of the carrier, the difference circuitry adds very little to the modulation swing.

In fact, as far as modulation percentage is concerned, the sum and difference signals

lower frequency than the suppressed carrier and it can also be held to a constant, modest level. In fact, the standards assume that the reference signal need be responsible for not more than 10pc of the permissible deviation, leaving the remaining 90pc to be shared between the sum and difference signals.

Fig. 2 depicts the frequency spectrum which is ultimately frequency modulated on to the carrier of a stereo FM transmitter.

The frequencies 30 to 15,000Hz are the direct audio components obtained by adding the left and right stereo signals — the mono signal.

Just beyond the audio range is the 19kHz reference or pilot tone.

The region from 23kHz to just short of 38kHz accommodates the lower sideband of the difference information signal. At 38kHz is a notch where the difference carrier has been suppressed and, beyond that, out to 53kHz are the upper sidebands of the difference signal.

The vertical scale of Fig. 2 is also significant. It shows the pilot tone at a 9pc

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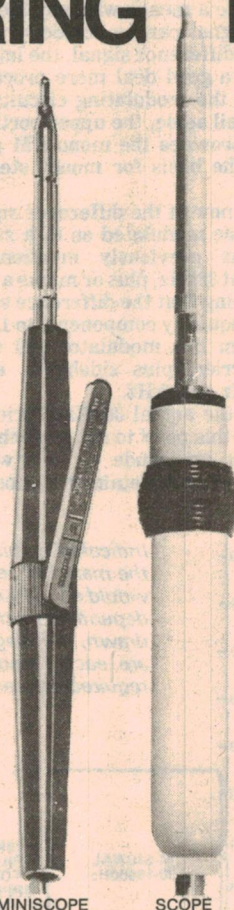
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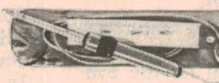


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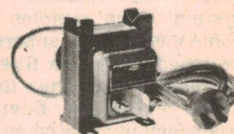
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FM-STEREO

level of modulation and the sum and difference signals sharing the remaining 90pc. As indicated earlier, the relationship between these two is dynamic, the sum or mono signal tending to rise above 45pc modulation as the difference signal falls below it.

So much for the transmitted signal, but what does it all mean at the receiving end?

Receivers will be the subject later of more detailed discussion but, in essence, they reverse the process outlined for the transmitter and illustrated in Fig. 1.

They receive the incoming carrier and, following normal superheterodyne practice, reduce it to an intermediate frequency usually centred on 10.7Mhz. It is then fed to an FM demodulator of one type or another and the modulation extracted.

In the simplest case — a conventional mono receiver or tuner — the modulation products encounter a de-emphasis filter intended to reduce the level at 10kHz by the appropriate 10 or 15dB. Naturally enough, the de-emphasis network heavily attenuates the pilot tone at 19kHz and the "difference" sidebands in the region 23-53kHz, so that not much of this extra information will reach the amplifier. Even if it does, being beyond audibility, it will not be noticed by the listener.

This observation must be qualified in one respect. While to 19kHz pilot tone is normally above audibility, it can cause possible problems if the incoming signal is being tape recorded. The pilot tone, or one of its harmonics, may happen to beat with the recorder's bias frequency to produce an audible note, which then appears on the tape. Because of this possibility, it has become virtually standard practice to fit all FM receivers and tuners with a trap circuit intended to keep the pilot tone out of the audio circuit.

But let's get back to the main theme:

In a stereo FM receiver or tuner, every effort is made to preserve the full range of modulation components at the output of the demodulator, the components then being directed and processed as necessary.

First off, the basic audio modulation, or sum signal, is isolated and made available for subsequent merging with the difference signal.

The 19kHz pilot tone is also isolated and made available to phase lock a locally generated 38kHz signal, essential for demodulating the difference sidebands.

These sidebands, in turn, are demodulated to recover the original "difference" information. By matrixing sum and difference components in the appropriate amplitude and phase, it is possible, as we have already seen, to recover the original left and right stereo signal information. Suitably de-emphasised, the stereo pair is passed on to the amplifier system.

The stereo signals may be just a stereo pair, or they may contain additional information, in turn, for matrixed quadraphonic presentation. In short, if an SQ, QS or RM quadraphonic disc is placed on the turntable of an FM station, the signal will be processed and transmitted as normal but it will be capable of being decoded at the receiving end, just as if the disc were being played on the system's own turntable.

No agreement has yet been reached on



Sony's compact, home music system HP-179A incorporates an FM-stereo tuner, as well as AM tuner, record player and cassette recorder. FM tuners — mono or stereo — with any chance at all of being used with a tape recorder should have a 19kHz trap built-in to minimise the risk of interaction between the pilot tone and its harmonics, and the tape system bias oscillator.

the transmission of fully discrete quadraphonic material, as from CD-4 discs. These discs involve their own supersonic modulated carrier which could well cause all manner of problems if it was allowed to reach the modulating circuits of the FM transmitter. Almost certainly, such discs would have to be decoded first into discrete 4-channel audio, before being re-processed like any other 4-channel signal for modulation on to the FM carrier.

In the USA, the Electronic Industries Association has formed a committee to consider the whole problem and they are currently examining about 10 different systems. The objective now is to maintain full compatibility with existing mono and stereo equipment. Curiously, one of the biggest stumbling blocks, for the USA at least, is the presence of the 67kHz background music or "storecasting" sub-carrier, a facility which the FCC seems determined to preserve.

At present, the most favoured of the 4-channel systems is known as the Dorren, after its inventor.

In broad terms, all four signals are applied in sum to the main modulation circuit, to provide the basic mono sound. The normal 38kHz sub-carrier system contains the difference information but it is essentially the difference between the total left and total right. With this, a conventional stereo receiver can recover an acceptable 2-channel version of the program.

However, an additional (suppressed) carrier with sidebands is centred on 76kHz — 4 times the pilot tone — and these contain the difference between the respective front and back pairs. A suitably designed quadraphonic receiver can accept these extra sidebands, balance and matrix them with the rest of the signal information to recover the original four discrete signals.

With this scheme, the "storecast" carrier is moved out to 95kHz, five times the pilot tone.

It is conceded that the ultimate station

bandwidth will tend to be somewhat greater than with a conventional stereo broadcast but supporters of this and similar schemes are confident that they can maintain the outer sidebands to a level acceptable to the FCC, and to a level which will not cause inter-channel interference. The real problem may well be the one faced by receiver manufacturers, who will have to come up with a passband wider and squarer than ever before.

Earlier, reference was made to the matter of signal / noise ratio. It was pointed out that reduction of the "sum" modulation on a stereo program, as compared with full equivalent modulation of a mono transmitter, produced a potential degradation of about 4dB in signal / noise ratio, even when received in mono mode.

Received in full stereo mode, the potential degradation in signal / noise ratio is much greater. In broad terms, this can be accounted for by (1) the reduction of effective deviation for the signal components: (2) the aggregate noise contribution of two channels rather than one and (3) the involvement of an amplitude modulated system with its attendant susceptibility to noise interference.

Because of these factors, the signal / noise ratio for stereo mode reception is likely to be degraded by at least a further 10dB from mono mode reception of the same transmission. Compared with an equivalent mono transmission, the potential signal / noise degradation in a weak signal area adds up to about 15dB; some put it at nearer 20dB.

To some extent, the difference can be countered by the use of higher gain, more directional aerials, perhaps motorised, but the fact remains that stereo reception can pose problems in fringe situations.

Recognising this, modern stereo tuners incorporate provision for manual or automatic reversion to mono mode when the input signal falls below a predetermined level.

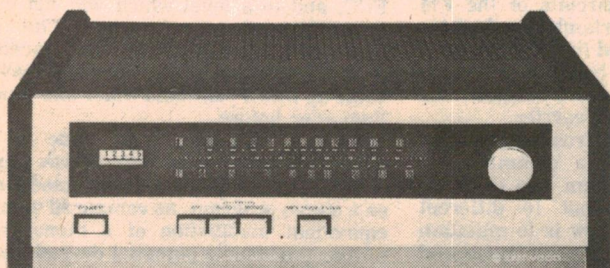
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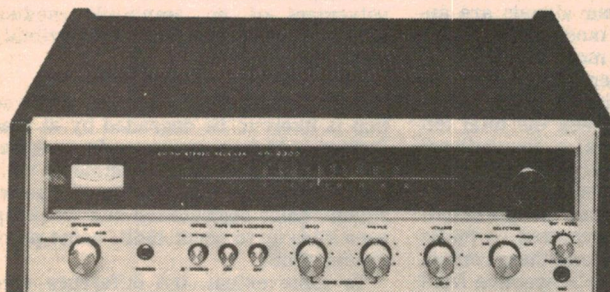


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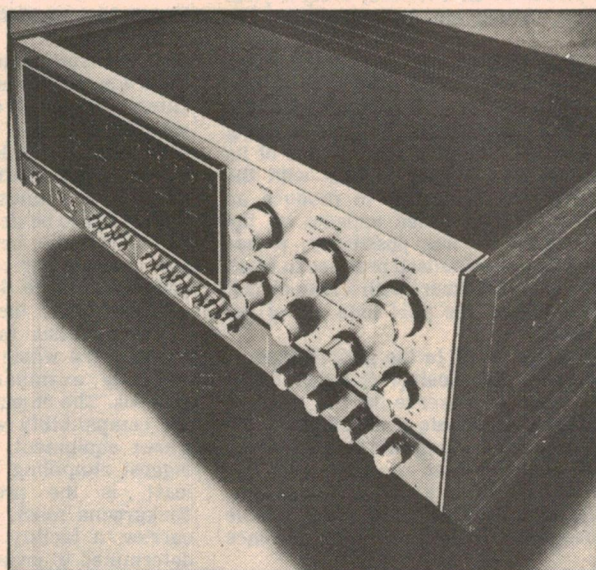
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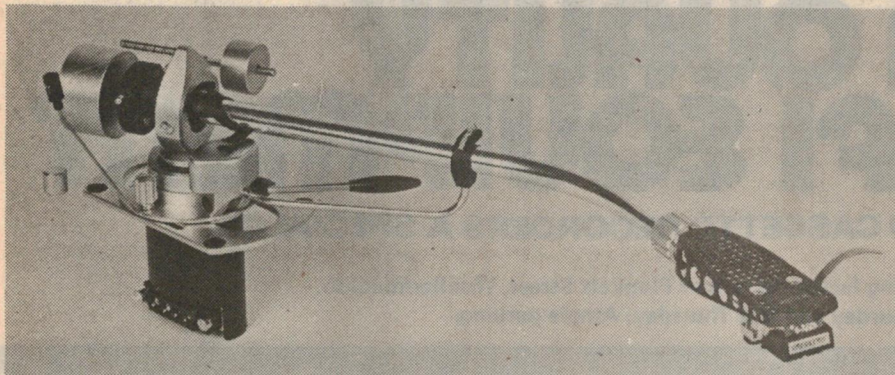
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JM/K-44-74

Shure V15 Type III and SME model 3009 series 2



The quest for flawless record reproduction has brought the development of magnetic cartridges and tone arms up to a high stage of precision. At the forefront of this development must be the Shure V15 type III magnetic cartridge and SME model 3009 series 2 improved tone arm, which we review here.

While the majority of high fidelity systems in use today employ an automatic turntable there are still many enthusiasts who prefer to use a manually-operated tone arm. In theory, a tone arm free of the encumbrances of being part of an autochanger mechanism should function more efficiently.

The "SME model 3009 series 2 improved," to give its full title is perhaps the most well-known tone arm for use with a non automatic turntable. (I dislike the term manual; after all, turntables have been motor-driven ever since I can remember). The SME arm has adjustments for static balance in the vertical and lateral planes, as well as antiskating compensation.

In the improved version, the main-counterweight which is mechanically decoupled from the arm, has been made more compact so that it can be moved closer to the pivot and thus reduce the arm inertia. The range of stylus tracking weight available on the outrigger system is 0 to 1.5 grams.

Antiskating compensation is provided by means of a small weight hanging by a nylon thread which runs over a miniature pulley and is attached to a lever on the arm pivot. The lever has graduations on it which coincide with those on the tracking weight outrigger. The pulley is one of the recent improvements; previously, the bias guide as it is called, was just a loop of heavy gauge wire.

A hydraulically-damped lifting and lowering device is incorporated in to the arm, as a matter of course. The arm base is fitted in a slide so that it can be precisely

adjusted for stylus overhang, or more precisely, for minimum tracking error.

Instead of having the arm rest as a separate fixture, the SME arm rest is cantilevered out from the base. It has a self locking clip which is a change from the previous wire clip.

A commendable feature of the SME arm is the very low bearing friction in both vertical and horizontal planes. It must have the lowest bearing friction of any arm we have tested.

As a further refinement, the SME arm is available with a fixed instead of removable headshell. Some may regard this as a backward step, as it makes cartridge installation and removal more difficult. Nevertheless, SME feel that the elimination of the locking collar and bayonet section from the already lightweight headshell afford a useful reduction in mass. Whether the reduction in mass gives an audible improvement in tracking is a moot point.

We reviewed the version with removable headshell as pictured. Another improvement that will be noticeable to those familiar with the previous model arm is the side-entry socket for the audio leads. This allows a more shallow plinth to be used for the turntable than previously.

The audio leads are terminated in machines phono plugs and are of low capacitance, about 140pF per channel. This means that there is very little attenuation of the cartridge high frequency response.

The cartridge in question was the Shure V15 type III which represents quite a large change over the type II. While the superseded type II was one of the best cartridges

available at the time, it did not have a flat frequency response; it had a 3dB depression centred on about 8kHz. While this was curable with appropriate changes to the equalisation circuitry, it still represented a deviation from the ideal.

While the type III appears very similar to the type II, it is electrically quite different and the stylus assemblies are not interchangeable. Shure has reduced the effective tip mass of the elliptical stylus and now used a laminated core and pole-piece structure. Output of the cartridge is unchanged at 3.5mV at 5cm/sec.

We installed the cartridge and arm according to the well written instructions and found no real problems. We linked the facility for rotating the headshell so that the cartridge is correctly oriented with the record surface. Balance and antiskating adjustments and straightforward to make. Tracking weight calibrations on the arm appear to be within at least 50 milligrams of their stated value.

Recommended tracking weight range is from $\frac{3}{4}$ to $1\frac{1}{4}$ grams. We found that with the tracking weight set to 1 gram, the V15 would comfortably handle all our difficult records except for the savage plus 18dB 300Hz lateral tracking test on CBS STR110. This required $1\frac{1}{4}$ grams. No apology needs to be made for this.

Frequency response was checked using the CBS STR 100 test disc. As it happens, we need not have bothered — it was ruler straight from go to whoa. Putting it in a more customary way, within plus or minus 1dB from 20Hz to 20kHz. And separation between channels was very good at minus 29dB in both directions, and never less than 20dB over the range from 50Hz to 10kHz.

Viewed on an oscilloscope, the waveform for sine and square waves was always very good. In fact there is very little to criticise with the V15 type III. With the SME arm we did find a few small hassles: the arm rest faces the wrong way (you have to lift the arm out and over it) and it is annoying to have to release the self-locking clip every time to play a record.

So how does the combination sound? That is the hardest question to answer. It does not really "sound" at all. Compared with other cartridge and arm combinations it tracks better, has a flatter frequency response, has greater clarity in the highs and lows. What more can you say, except that its a superb combination.

Further information and recommended retail prices for Shure and SME products can be obtained from the Australian distributors, Audio Engineers Pty Ltd, 342 Kent Street, Sydney, NSW. (L.D.S.)

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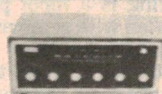
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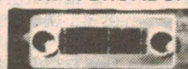
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Kenwood KL-7090 Loudspeaker 5-way

The Kenwood KL-7090 is the most complicated loudspeaker system we have ever tested. A 5-way system, it employs no less than 6 driver units — the largest of which is the 380mm woofer. It was submitted for review by Jacoby, Mitchell Pty Ltd.

First impression of the Kenwood KL-7090 is that it is a very well finished loudspeaker system. The front grille is elegantly styled and is removeable. The grille covers a similarly well-finished baffle in walnut veneer, which accommodates a profusion of loudspeakers.

One can almost imagine proud owners using the units with the grilles permanently removed so that they could feast their eyes at any time on the impressive array.

Largest of the six loudspeakers in the system is the 380mm (15in nominal) diameter woofer which had determined the width of the enclosure. In spite of its bulk,

appeared little different from any other large loudspeaker. We measured its free-air resonance at 30Hz which tends to bear this out.

In the enclosure, we found the resonance of the woofer rose to about 80Hz and although acoustic damping material is used on the insides of the box we would have expected the bass response to taper fairly rapidly below this frequency.

A complex crossover network, comprising three ferrite-cored inductors, five non-polarised electrolytic capacitors and thirteen resistors, splits up the audio spectrum in conjunction with the four-

A complicated approach to loudspeaker design, one must agree. With such small segments of the signal being handled by each transducer, it should minimise Doppler and intermodulation distortion. But unless a lot of care is taken with the crossover network and with loudspeaker orientation on the baffle, all sorts of frequency and phase irregularities can occur.

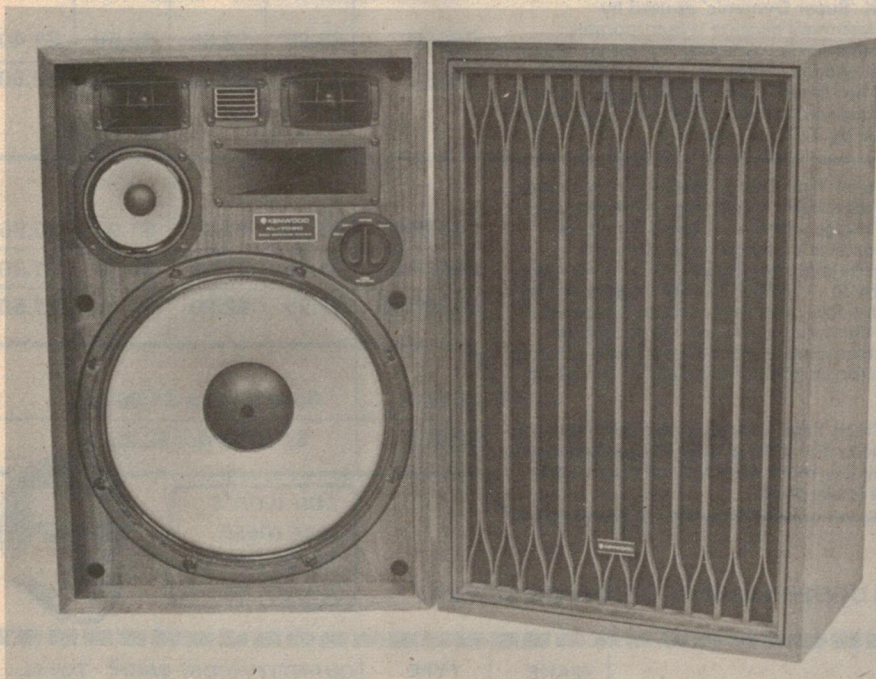
One trusts, of course, that the designers are aware of these problems but the point is made to highlight the difficulties of this approach to wide-range loudspeaker design.

Before making measurements, the loudspeakers were set up in conjunction with a high quality cartridge, turntable and stereo amplifier and listening tests made with a wide variety of records. This was done both in the home of a staff member and in our laboratory. We found the efficiency to be relatively high compared with most systems on the market and power handling was generous to say the least. In fact, Kenwood rate the KL-7090 for a maximum input of 120 watts. From our experience, the KL-7090 should comfortably handle the program output of amplifiers rated up to 60 watts continuous and more. The result is that they can produce more than enough volume, even for those pop enthusiasts who are out of their mind.

On popular instrumental music, the system gives quite a good account of itself but on classical music, particularly large orchestras it is disappointing because of what appears to be colouration. We cannot state what appears to be the direct cause. Certainly, there is a tendency to peakiness in the 2 to 3kHz region and also in the 8 to 9kHz region but this would not account for the problems we heard. Bass is reasonably strong down to below 80Hz and it tapers below that, as expected. Above 10kHz, the response also appears to taper off faster than expected in spite of the horn tweeter covering that range.

Certainly, there are many people who will be satisfied with the Kenwood KL-7090 performance and its elegant styling should appeal to the ladies whether they are interested in music or not. But classical music enthusiasts may have to listen carefully to it before deciding to purchase.

Recommended retail price of the Kenwood KL-7090 loudspeaker system is \$599 a pair. Kenwood equipment is available from high fidelity retailers throughout Australia. Further information can be obtained from the Australian distributors, Jacoby Mitchell and Company Ltd, 215 North Rocks Road, North Rocks, NSW. (L.D.S.)



the enclosure is relatively small to house a woofer of this size, especially considering that it is a sealed and not a vented system. Dimensions are 421 x 633 x 292mm (w x h x d) and the weight is 23kg.

The woofer has a voice coil of approximately 70mm in diameter and employs a very large ceramic magnet. Kenwood term the woofer a free-edge type but apart from a viscous damping material on the suspension of the heavy curvilinear cone it

position tone selector switch on the front baffle.

Over the range from 800Hz to 2kHz, signals are handled by the 120mm loudspeaker while from 2kHz to 5kHz signals are handled by a large horn driver. Then from 5kHz to 10kHz the output comes from two multicellular horns in parallel. Above 10kHz signals are handled by a small horn tweeter with what appears to be a diffraction grille in front of it.

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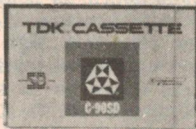


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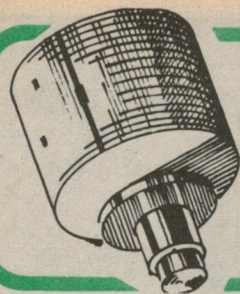
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News Highlights



Low-loss optical fibres from Bell and Corning

Recent advances in fibre manufacturing techniques by two American companies may hasten the time when light pulses will transmit voice, data and video signals throughout a communications network. Communications systems using light will have a much greater signal-carrying capacity, with potentially less cost and less dependence on natural resources, than existing transmission facilities.

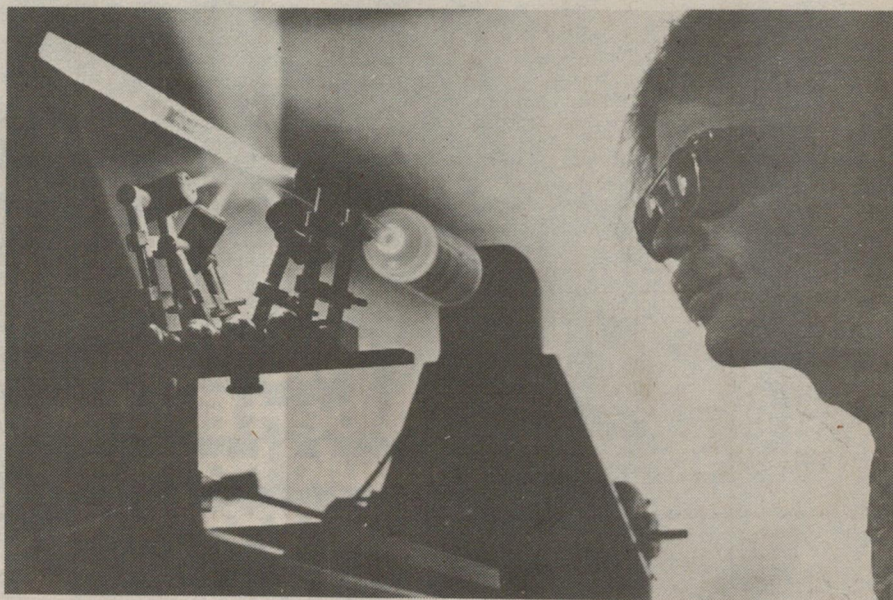
Scientists at Bell Laboratories have devised a new manufacturing process for making low-loss light fibres. Light sent through fibres made by the new process loses only about one third of its intensity over a distance of one mile. In ordinary glass of the sort used in window panes, this order of reduction in intensity would occur in a small fraction of an inch. The amount of light loss is directly related to the presence of residual impurities and imperfections in the glass fibre. It is important to have as low a light loss as possible in order to cut down on the number of amplifying stations in long-distance optical communications systems of the future.

Another important feature of optical fibre performance has also been improved in the new Bell Labs process: the dispersion characteristics. Dispersion is caused by the fact that some light within each pulse travels in a zig-zag path during its passage along the fibre, thus travelling slightly farther (and taking longer) than light that travels in a more direct path. As a result the pulse signal may spread out, and may eventually merge with another pulse, thus lowering the information-carrying capacity of the fibre.

Dispersion can be reduced by varying the composition of the fibre radially to produce a graded index of refraction. This causes the light following a zig-zag path to travel slightly faster than the direct light so that all of the light from a given pulse will arrive at its destination at the same time.

The new process is derived from a technique widely used in the semiconductor industry and is known as chemical vapour deposition. The glass fibre core, and in some cases its surrounding glass jacket (the "cladding") are formed, layer after layer, from gases passing through a fused quartz tube. The gases are heated sufficiently to react with one another, and are fused on the inner wall of the tube. The chemical composition of the layers is systematically varied by altering the gas flow, thus creating a graded refractive index throughout the layers.

These gases are the same as those used in semiconductor production, and are nearly free of all the impurities which can cause light loss. At the same time, the fused quartz tube protects the deposited material



Pictured is Bell Labs scientist G. William Tasker controlling the new fibre manufacturing process. Heat causes gases to react and fuse on the inner wall of a quartz tube which is later collapsed to a solid rod and drawn into thin fibre.

from contamination from the ambient environment during the processing.

After sufficient core material has been deposited within the fused quartz tube, the tube is collapsed by further heating and then drawn into the thin fibres that will transmit the light pulses. A ten-inch section of collapsed tube, of less than one-half inch diameter, may be drawn into a fibre more than a mile long.

In the Bell Labs experiments the fibre, exhibiting the lowest loss consisted of a pure fused-silica core with borosilicate cladding. This transparency occurred at the infrared wavelength of 1.06 micrometres, where a laser light source acceptable for optical communications exists. For some conditions of excitation, losses as low as 1.2-dB/km have been observed.

Another company that has made important advances in the field of glass fibre manufacture is the Corning Glass Works, with whom Bell Labs scientists have been comparing results. The company has been successful in producing fibres through a different, though related, process to the Bell Labs technique, with light losses closely approaching those of the Bell Labs fibres. The maximum signal attenuation is specified by Corning as 30dB/km at a wavelength of 820 nanometres.

The low-loss glass optical waveguides manufactured by Corning are now available for the construction of prototype systems, and are suitable for use in development programs involving broadband networks, data processing, process control systems and military communications systems.

Britain to export satellite sub-systems

The Electronic and Space Systems Group of the British Aircraft Corporation is to supply satellite sub-systems for the American Telephone and Telegraph Company's domestic communications satellite system. Initial deliveries on the contract will begin in November of this year.

The 24-channel space satellites will be used by the American Telephone and Telegraph Company to relay telephone traffic throughout the United States. BAC will

supply satellite spun structure assemblies, spacecraft integration equipment, de-spun structures, booster adaptors, separation sub-systems and power transmission assemblies. The first satellite will be launched from Cape Kennedy in 1976.

With the completion of the contract, BAC will have supplied 13 sets of revenue-earning space satellite equipment. The company is also manufacturing sub-systems for the larger and more powerful Intelsat IVA communications satellites.

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085.P.421

New communications satellite in orbit

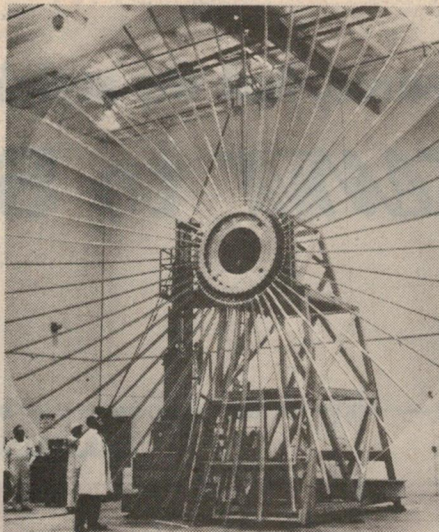
Shown in the accompanying photograph is a 30-ft diameter flex-rib antenna developed by Lockheed Missiles and Space Company, Sunnyvale, California, and used in the Applications Technology Satellite (ATS-F) launched from the Kennedy Space Center, Florida, on May 30, 1974.

The saucer-shaped antenna is constructed from aluminium ribs and Dacron mesh which is copper plated and coated with silicone. For the ride into space, the antenna ribs and mesh were wrapped around the antenna hub and held in position by a restraining cable. When the spacecraft arrived on station, a signal from the ground caused the cable to sever, allowing the antenna to unfold and begin operation.

US and Soviet space crews are planning to use the ATS-F communications satellite as a main communications link with Earth during their joint orbital flight scheduled for July 1975, provided the necessary tests and verifications are successfully completed over the next few months.

Although previous space communications have been relayed between ground stations using communications satellites, the Apollo-Soyuz Test Project will be the first to use a satellite to relay television and other communications directly from the spacecraft to Earth stations. The previous method of using satellites to relay messages between ground stations proved unwieldy during the recent Skylab missions. Because of Skylab's relatively low orbit of 435km, and the limited number of ground stations available, ground controllers were able to communicate with the crews for only 38pc of the flight time.

For the Apollo-Soyuz flight, communications time would be reduced to only 17pc of the flight time if this method were to be retained. However, by using the ATS-F to link the spacecraft with Earth, communications will be possible for 50pc of the



flight time. This will greatly increase the amount of real-time data available to investigators on the ground, as well as increasing the amount of real-time television coverage of the flight.

Lasers may trigger nuclear fusion plants

High energy laser research in progress at three Atomic Energy Commission laboratories in the US may unlock the door to a new source of clean, safe and low-cost electrical energy by the end of the century.

The investigations are directed toward a demonstration that high-energy laser systems can be used to initiate thermonuclear fusion on a scale compatible with a variety of power generating schemes.

Laser-induced fusion provides an alternative to the various magnetic confinement techniques that are currently being investigated as avenues toward controlled thermonuclear reactions.

The attractiveness of fusion power is based on the lower radioactivity of the reaction products as compared with fission processes, and on the virtually limitless supply of the fuel element deuterium, or heavy hydrogen, in the world's oceans.

The AEC's laser fusion program has been geared primarily to the US weapons program, for example providing a means of nuclear weapon simulation. However, it has both military and civilian energy production applications, according to Major General Ernest Graves, the commission's laser fusion program manager and assistant general manager for military applications. Some scientists believe that laser fusion could also eventually be used for space propulsion systems.

First-generation laser-fusion power plants probably would be analogous to fission plants, consisting of a reactor, heat exchanger and turbogenerator. Within the reactor, laser pulses in the range 100,000-1,000,000 joules could initiate fusion pulses of 10-100 million joules.

Advanced laser-fusion power plants might employ direct energy conversion techniques such as MHD (magnetohydrodynamic) hot-gas-generator conversion or plasma conversion.

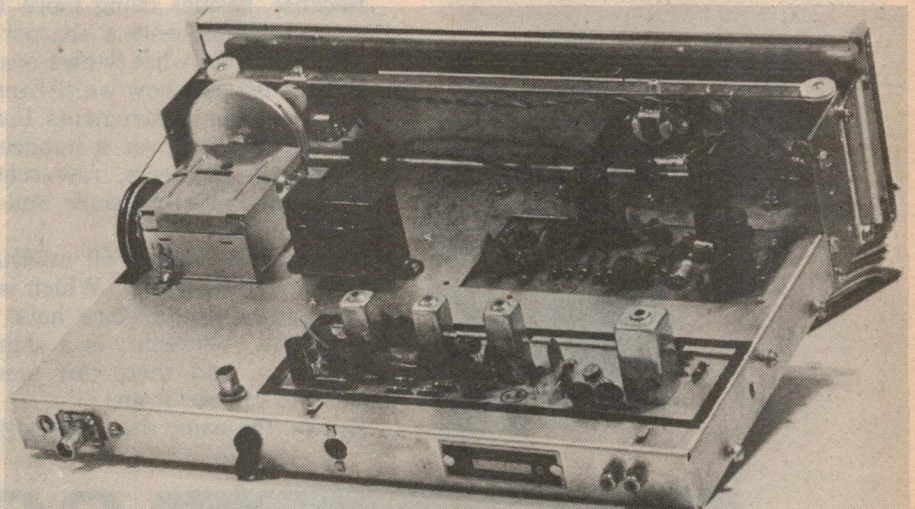
Although laser fusion may not find its way into commercial use for decades, the AEC expects to demonstrate a system that produces more energy than it consumes (net energy gain) by mid-1980. Major milestones along the route to this critical goal include a demonstration of significant thermonuclear burn by mid-1977, and of scientific breakeven — the condition where thermonuclear energy equals the amount of laser energy impinging on the fuel pellet — by mid-1979.

IC replaces IF strip in FM radio tuners

Signetics Corporation of Sunnyvale, California, have developed a new integrated circuit which will eliminate most of the tuned circuits in the IF strip of FM radio tuners. Retailing for just over US\$3, it replaces parts worth over US\$20 and allows for greater design simplification and ease of construction.

Designated by Signetics as the "NE563", the new 16-pin dual-in-line IC was specifically designed to minimise alignment procedures, and performs all of the standard peripheral functions that high-quality FM receivers derive from the IF section. These functions include AGC (automatic gain control), AFC (automatic frequency control), drive for a signal strength meter, and variable muting.

Technically, the NE563 is an advanced phase-locked loop circuit. It incorporates a double-conversion technique that provides the receiver with a higher frequency response, greater sensitivity, and lower distortion than was previously possible. The incoming IF signal of 10.7MHz from the front of the receiver is amplified and limited in the first section, which has a gain of approximately 66dB. Next, the signal can



This is the rear view of a typical FM stereo tuner. The section in the centre foreground, outlined in black, is the IF strip which the NE563 integrated circuit replaces.

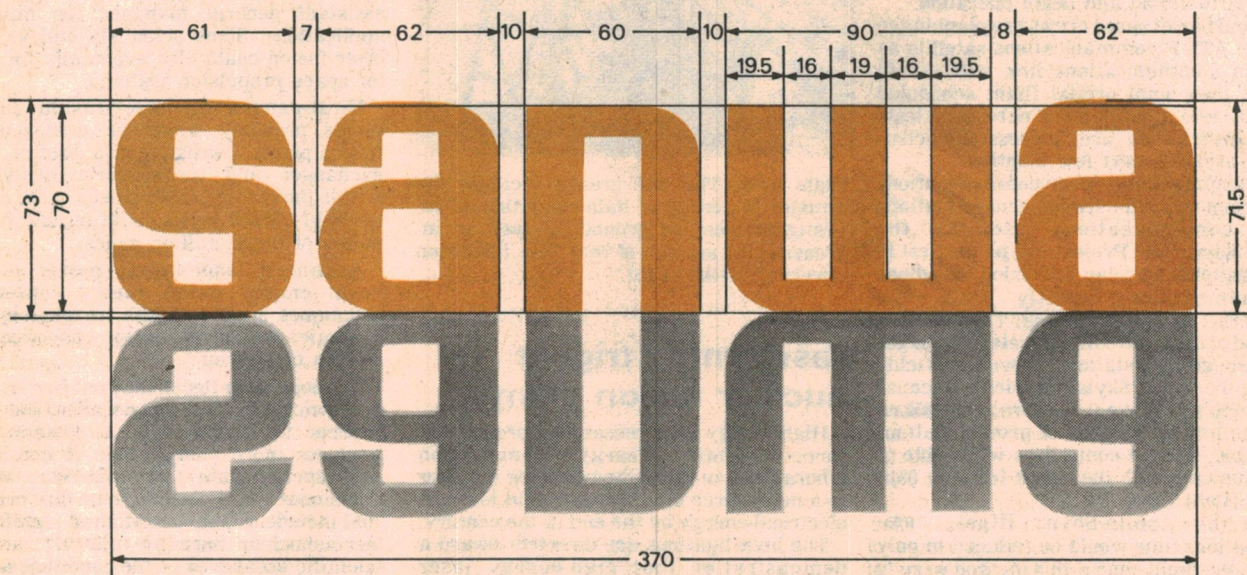
be routed through an external ceramic bandpass filter to provide the frequency selectivity required.

After passing through the filter, the signal is routed through two mixers and an external low-pass filter. Here the signal is converted to a frequency of about 1MHz and

used to drive the phase-locked loop demodulator section. The exact frequency of the local oscillator can be set with a crystal, ceramic, or LC resonator. The output from the NE563 integrated circuit is a low frequency stereo-composite signal and audio.

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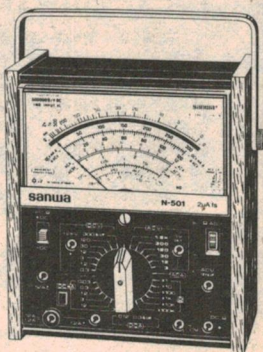
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NEWS HIGHLIGHTS

Computerised techniques aid land reclamation



Specialists at the Central Asian Research Institute for the Development of Land Irrigation and Reclamation in Uzbekistan (a Soviet republic in Central Asia) are using computerised methods to aid in the design of irrigation projects in arid areas. Electronic technology now solves a range of complex problems from the processing of topographic material to the issuance of blueprints for irrigation projects, together with cost estimates.

Already, more than 50,000 hectares

(123,500 acres) of land belonging to the state farms of Uzbekistan have been reclaimed with the help of electronic computers. Overall labour expenditure in this project is now down to 20pc of the total cost.

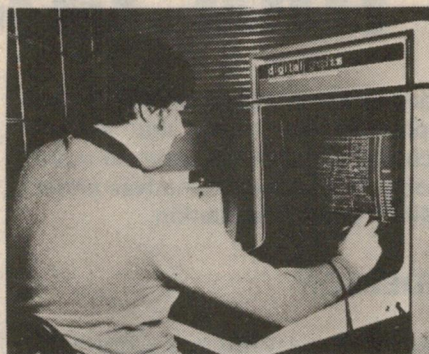
At present, land reclamation projects in the Soviet Union are served by 40 computer centres set up across the country. In 1973 alone, some 940,000 hectares (2,321,000 acres) of irrigated land were brought into production using computerised planning techniques. (Novosti Press Agency.)

Computer aided electronic circuit design

Techniques used in the design and manufacture of electronic circuits are being transformed by a computer-based design system pioneered and developed over eight years by a British based electronics firm, Redac Software Ltd, Gloucestershire, England.

The computerised design system, which is now being used by some of the world's leading companies, eliminates the lengthy trial-and-error circuit design and manufacturing techniques normally undertaken by circuit designers. The main design applications of the computerised system include: the design of single, double or multilayer printed circuit boards (up to 12 layers); the design of back panel layouts; and the design of micro and thin-film circuits. Conventional techniques, involving the production of layouts on oversized boards using opaque tapes and similar hand methods, are rendered obsolete by the computer design system.

The main machine-interface system consists of an interactive computer graphics terminal, which is linked to standard hardware. Resembling a television screen, the terminal is used to display diagrams and other graphic



material stored in the computer's memory. For electronic circuit design, this material includes all the various circuit elements, layout parameters, and general raw material needed by the designer to compose a circuit. The designer can call up any material for instant display, and by the use of a light pen can manipulate, position, change, and interconnect the various circuit elements as he chooses.

When the circuit design is finalised and approved by both the designer and the computer, it is stored with full details in the computer's memory. The design may be retrieved instantly at any time, and may be reproduced at a computer print-out terminal, or recorded on magnetic tape for automated production techniques.

New techniques for HF signal storage

Information storage phenomena, with potential applications in storage and processing of high frequency signals, have been discovered by IBM scientists at the IBM Thomas J. Watson Research Center, New York. Photo-sensitive piezo-electric crystals are able, through the new effect, to store microwave-frequency signals in a very small piece of material.

The most promising immediate application is probably in radar systems where the probe signal could be stored for comparison with reflected signals. At low temperatures, the effect also has promise for computer storage and for high resolution acoustic holography since it permits high density storage of information for long periods. Information can be erased simply by shining light on the sample.

Storage is accomplished in the piezo-electric crystal by a stable pattern of trapped electrons produced by interference between two input signals. Information is read out by applying a signal at the same frequency as that of one of the original input signals. This causes the sample to radiate a replica of the other input signal as an echo. The storage mechanism is therefore analogous to holography, in that the information stored is an interference pattern produced from an information signal and a reference signal.

Devices based on the new effect can store both phase and amplitude information over a bandwidth of 100MHz to 10GHz. Other possible applications include the storage of an acoustic signal as an acoustic hologram which could be read out optically; processing RF signals by interactions with acoustic signals to perform convolution or correlation of the signals; and integration of thousands of input signals for averaging to eliminate noise.

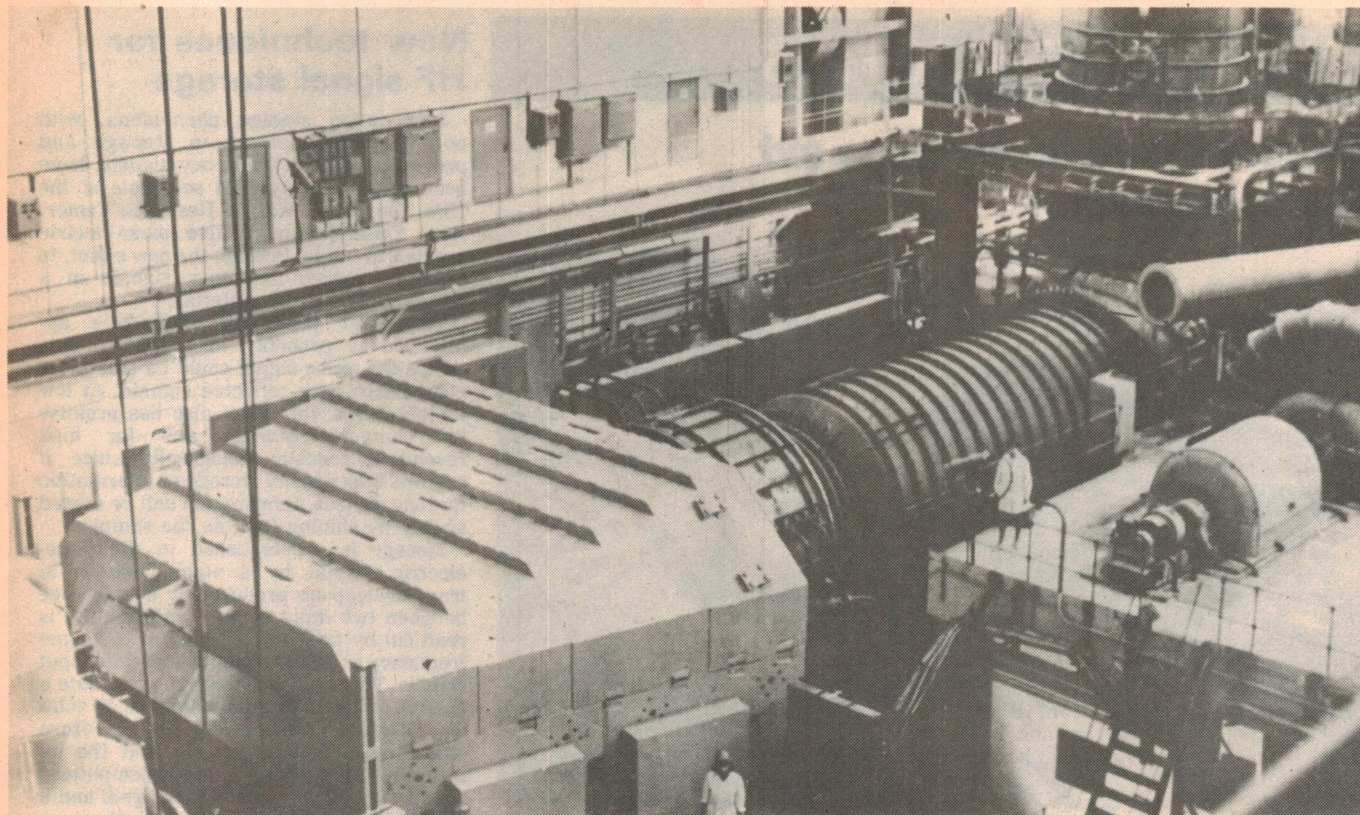
Remote medical monitor for high-risk patients

Remote medical monitoring techniques developed primarily for manned space flight, coupled with the technical know-how of a NASA Biomedical Applications Team, have led to the development of a new, portable device able to monitor continuously the condition of high-risk patients.

Now available commercially, the 1.8kg (four-pound) device, called Vitasign Attendant Monitor, is designed to operate from existing patient call systems and conventional electrical outlets. The device makes available, at moderate cost, continuous patient monitoring techniques previously found only in the intensive care units of large hospitals.

To operate the device, three electrodes are placed on the patient's chest. These monitor ECG (electrocardiogram) and respiration rate. A sudden change in the ECG signal, or changes in the normal respiratory cycle, automatically switches on an alarm light on the unit and activates a signal at the central call station to alert medical attendants.

The Vitasign Attendant Monitor is expected to be particularly useful in monitoring patients with cardiac diseases, muscular dystrophy, cerebral palsy, tuberculosis, and cystic fibrosis.



MHD Generators may ease the fuel crisis

One of the most pressing problems facing today's highly industrialised nations is the dwindling supply of fossil fuels. Euphemistically termed the "energy crisis," this situation has forced the research and development rate on more efficient methods of producing energy. Among the various alternatives under consideration is magnetohydrodynamic (MHD) power generation.

by EDWARD EDELSON

Standing inconspicuously in the parking lot behind the Avco Everett Research Laboratory near Boston is a trap-covered square tube, about as long as a family car and as wide as a desk, that's worth a second look. It's the heart of the Mark V, a magnetohydrodynamic (MHD) generator whose 32-megawatt output still holds the world's record. The Mark V was dismantled a few years ago, but, says Stanley Perry, an Avco engineer, "I just didn't have the heart to get rid of it."

The Mark V is all too symbolic of the MHD story to date: it's been around for a while, it's achieved tantalizingly promising results — and no one knows what to do with it.

For years, a handful of MHD proponents — most notably Arthur Kantrowitz of Avco

— have been saying that their system could increase the efficiency of electric generating plants by 50 percent or more. And for years, MHD research has been limping along on a minimal budget: a few dollars from a corporation here, a small grant from a utility there, a minor effort on the part of the federal government.

There have been some encouraging signs for MHD lately, such as a US Soviet agreement to cooperate in research, and a slight increase in federal appropriations. However, the energy crisis has created a moment of truth for MHD. As far as people in the field can tell, it's now or never. Either the government comes through with a "quantum-jump" increase over last year's \$5.75 million, or the immediate future for MHD development looks dim indeed.

"If the energy crisis can't put MHD over," said one expert I talked to, "then nothing can."

MHD engineers have an offer they think you can't refuse: give them the money and the time — about a half-billion dollars and a decade — and they'll give you a generating station that has no moving parts, is almost pollution-free, and produces perhaps 4,500 kilowatt-hours of electricity for every ton of coal, compared to just 3,000 kilowatt-hours for today's best generating plants.

For a nation that's suddenly fuel-hungry, that offer should be irresistible. But the small band of MHD enthusiasts have said the same thing for a long time without getting anywhere — and you can't blame the jawbreaking name they're stuck with. If one looks at the sort of problems MHD has to overcome, it is easy to understand why its proponents encounter scepticism.

Basically, magnetohydrodynamics consists of passing a high temperature highly ionised gas through a magnetic field and tapping off the electricity generated. A temperature of around some 5,000 degrees F is required to ionise the gas into what physicists call a plasma. This process strips electrons away from many atoms so that the gas becomes a good conductor of

electricity. The plasma is then expanded through a rocket-like nozzle, and sent roaring down an electrode lined channel at about the speed of sound. Additional ionisation is achieved by seeding the gas stream with caesium or potassium carbonate.

The walls of the channel, and the electrodes through which electricity is drawn off, must be protected from all sorts of damage — melting due to heat, erosion caused by the sheer speed of the gas, corrosion from the seed metal atoms and, if coal is used as a fuel source, the impact of ash particles. What's more, the channel must be confined within the poles of a superconducting magnet whose field must be 50,000 gauss or more and whose size approaches that of the family garage.

Downstream, the extra-high levels of eye stinging nitrogen oxides produced by the high temperatures of MHD must be dealt with, as well as the sulphur oxides and ash that come out of any plant burning coal or oil fuel. And the extra efficiency promised by MHD power plants is lost if corners are cut. Lower gas temperature means less conductivity, a reduced electromagnetic field means less generating capacity, and too much pollution means a visit from an inspector. So meeting the standard for MHD success seems like a tall order — and it seems even taller when one learns just how limited MHD experience has been.

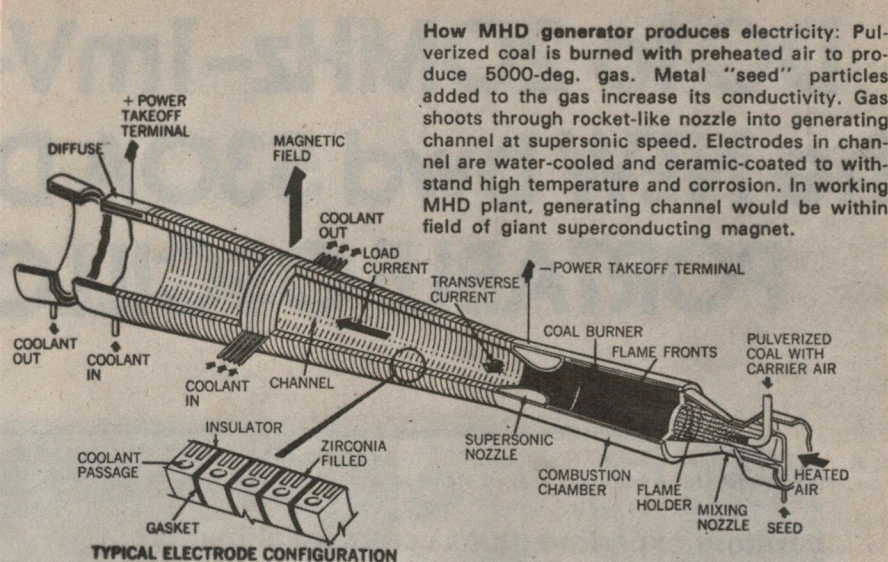
MHD theories have been around since Michael Faraday discovered the principle of the generator. However, the first MHD generator was not constructed until after World War II, and even today operating experience on these generators is not very impressive. Engineers have run 10kW MHD generators for periods of up to only a few hundred hours at a time, and operating times of megawatt-level MHD generators is measured in minutes. Avco's Mark V never even ran for an hour continuously.

The world's current largest plant is the Soviet U-25, designed for an ultimate capacity of 25MW. Built in a northern suburb of Moscow, it has only a few hours' total experience at four megawatts or less. It does, however, have the distinction of being the world's only MHD generator that is tied into a working power grid. US experts say the Soviets have made a major achievement in overcoming the engineering problems that accompany putting a promising concept into actual operation. Thus, the experts are impressed with the U-25's interconnecting equipment, but not with the MHD core. For, one of them said, the Soviets went ahead and built the kind of MHD plant we could have had if research had ended in the mid-1960's.

Still, MHD people say they can talk realistically about a plant that would operate at 1,000MW for hundreds or thousands of hours. Their reasoning: research has already overcome the critical problems, and the rest is just a matter of tinkering with known principles.

"The problems we face aren't of a basic physics nature," says Raymond Janney of Avco. "They're purely of an engineering nature."

The best reason for listening to statements like this is the hope that MHD can stretch our precious supplies of fossil fuels. Today's best coal or oil-burning plants, operating at 1,000 degrees F, turn about 40 percent of the fuel's energy into electricity. The rest is waste heat. Nuclear



Above is a cutaway diagram showing the essential parts of an MHD generator. The photograph on the facing page is of the Soviet U-25 MHD generator which has a potential capacity of 25MW and is the only MHD generator tied to a working power grid.

plants, running a few-hundred degrees cooler, are only about 33-percent efficient. MHD people talk about total efficiency in the area of 60 percent, meaning they'll get half again as much useable energy out of coal or oil as we do right now.

MHD would get the extra efficiency in two ways — by using its combustion gas directly, eliminating the waste of making steam to turn a generator; and by using a hotter gas — the basic rule of a heat engine says that the hotter you can run it, the more efficient it will be.

There are three MHD concepts aimed at reaching this promised land of high thermal efficiency. Far in the lead is open-cycle MHD, in which gases heated in a combustion chamber are sent directly through the generating channel. Much more work has been done on the open-cycle concept than on the competing closed-cycle proposals, in which heat is transferred either to a noble gas or to a liquid metal, which then runs through the channel. It's the open-cycle people, led primarily by Avco engineers, who are talking about building a pilot plant now.

But to believe that open-cycle MHD can make it, one has to look at a lot of small pieces of evidence from several laboratories. Consider what looks like the main technical challenge in MHD — preserving the channel from the assault of that powerful blast of hot gas. Even today's best refractory ceramics, such as zirconia or magnesia, are ripped away too quickly.

The solution to this problem is to feed in a refractory powder with the fuel so that the coating on the channel walls is continuously replaced as it is scoured off. If the rate of feed is just right, the channel gets the protection it needs.

Here, the MHD people think they've hit it lucky. Work at Avco and the University of Tennessee Space Institute indicates that ordinary coal slag does just as good a job of channel coating as the most exotic refractory material. "If we had set out to create an ideal material for wall coating, we would have come up with something just like coal slag," exults Avco's Richard J. Rosa.

How MHD generator produces electricity: Pulverized coal is burned with preheated air to produce 5000-deg. gas. Metal "seed" particles added to the gas increase its conductivity. Gas shoots through rocket-like nozzle into generating channel at supersonic speed. Electrodes in channel are water-cooled and ceramic-coated to withstand high temperature and corrosion. In working MHD plant, generating channel would be within field of giant superconducting magnet.

But that rejoicing comes after short-run tests: it has yet to be shown that coal slag will work under continuous plant operation. Avco's 500kW Mark VI is currently setting up for a 100-hour trial run, possibly later this year. J. B. Dicks and his co-workers at the University of Tennessee are also aiming to run their MHD generator continuously for 100 hours, using coal ash as a fuel source. The idea has looked good in brief runs, but as Dicks points out, "If we run it for a few hundred hours, problems that we can't see now could become appreciable."

As for controlling the amount of ash that goes in, the Bureau of Mines Research Center in Pittsburgh is working on a novel three-stage combustion chamber that would do just that. But it isn't ready yet.

Neither is the superconducting magnet needed for a large-scale generating plant. MHD researchers at Stanford University are about to get an 80,000-gauss superconducting magnet, but that will be used for basic scientific studies.

Without a superconducting magnet, the whole MHD generator idea would collapse, because an inordinate amount of energy would be needed for a conventional electromagnet of the necessary size. Yet, as Dicks points out, "No one has ever run an MHD generator with any superconducting magnet, aside from some very small experiments in Europe."

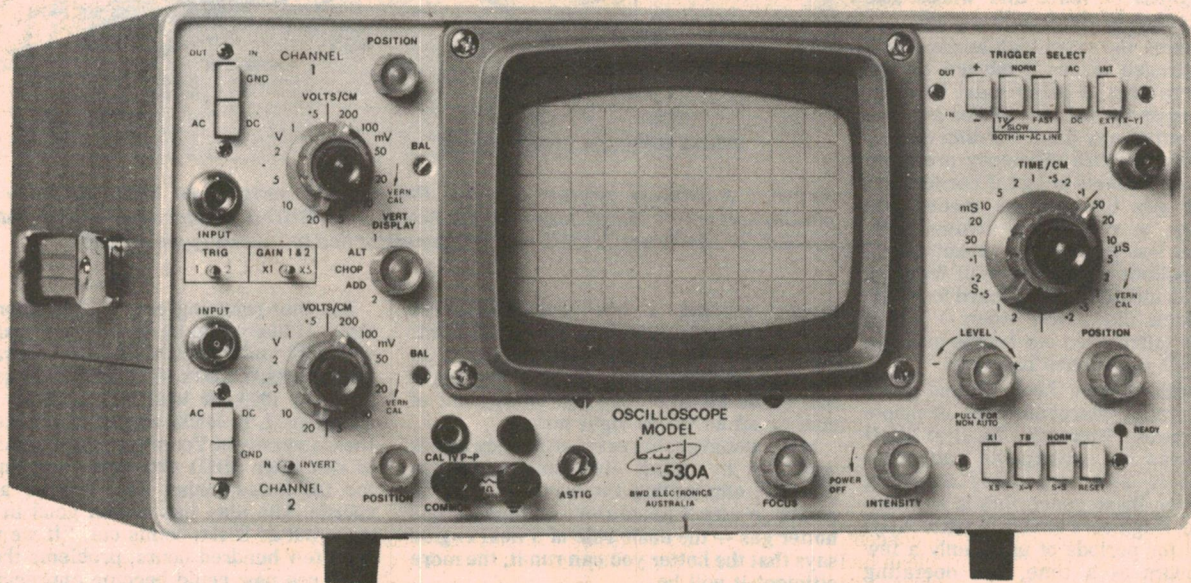
The MHD advantage is that pollution control is not a tack-on as with today's systems. But, of course, none of the MHD pollution controls has been proven in prolonged plant testing. Consider the plan for controlling pollution. Nitrogen oxides, a special problem for MHD because they increase directly with combustion temperature, would be handled by a two-stage burning process, using an afterburner to eliminate them. Sulphur oxides and ash would be collected with the seed metal; the seed would be separated out chemically and recycled, while pollutants would be dumped harmlessly.

But if open-cycle MHD has some open questions, the closed-cycle concepts are more like a gleam in someone's eye.

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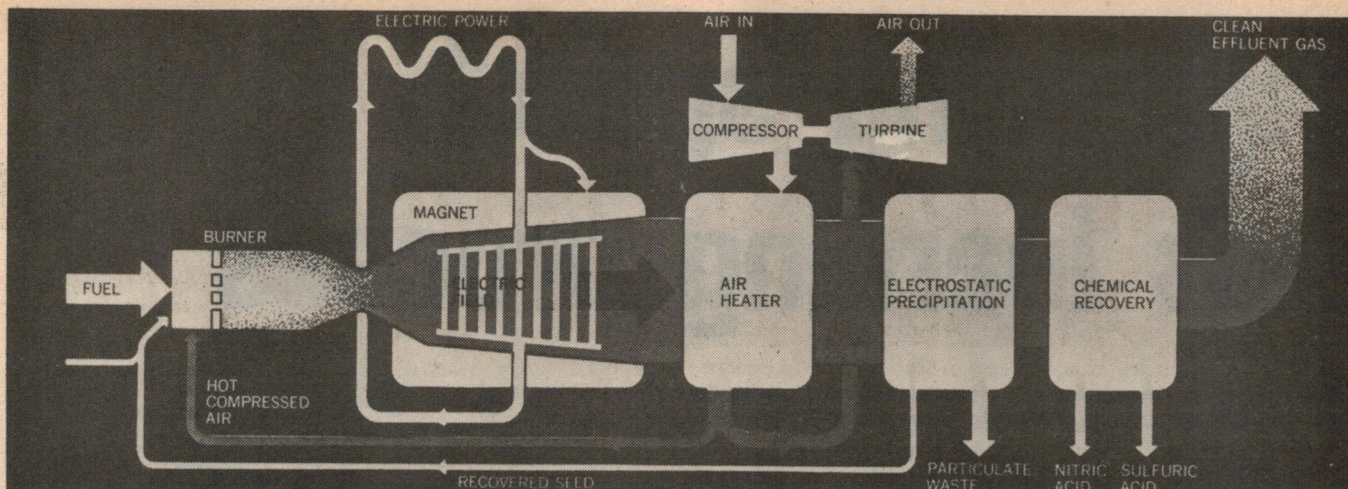


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Laboratory in Valley Forge, Pennsylvania, has something like a monopoly on closed-cycle noble gas MHD. Bert Zauderer, who heads the program, is enthusiastic about the scientific elegance of the idea: instead of heating all the gas to 5,000 degrees F, the idea is to selectively excite only the electrons in the noble gas (in much the same way that electrons in a fluorescent bulb are excited), thus getting the same gas conductivity at a much lower overall gas temperature.

As Zauderer pictures it, a closed-cycle, noble-gas MHD generator would have several columns of ceramic pebbles that would be heated by combustion gases and would transfer that heat to argon or another noble gas, which would then flow through the generating channel.

Zauderer admits that his scheme is five or six years behind the open-cycle concept, that it would need excruciatingly clean fuel to avoid fouling the ceramic pebbles, and that many scientists doubt that selective heating of electrons can be done. "We're the only ones who can get it to work," he said of his concept.

But even though Zauderer measures operating times in milliseconds — all his experiments have been done in shock tubes thus far — he maintains that given \$25

The above diagram shows how MHD could improve efficiency and lower pollution. After MHD power generation (first stage), exhaust gas heats air to run a steam turbine and to preheat MHD fuel. Fly ash from coal would be recovered with metal seed and recycled, whilst nitrogen oxides and sulphur oxides from exhaust gases could be processed for industrial use.

million and eight or nine years, his closed-cycle scheme will reach demonstration-plant status. (GE is spending about \$500,000 on MHD research this year.)

Still further behind is a closed-cycle MHD concept that would use liquid metal as the generating fluid. Michael Petrick of Argonne National Laboratory, where the closed-cycle liquid-metal work is being done, likes the idea because of its low operating temperatures — in the neighbourhood of 1,500 degrees F — and because the system could be used with the liquid-metal fast-breeder reactor that's now under development and perhaps with fusion plants.

The problem with liquid metal — sodium is the leading choice — is that it doesn't flow fast enough, and until recently engineers haven't been able to manage to pump in gas to speed the flow. But just now, Petrick is talking about "something of a breakthrough," a method of injecting gas that has doubled efficiency. "It's beginning to look really attractive," he says.

Petrick has a timetable: run a 100kW

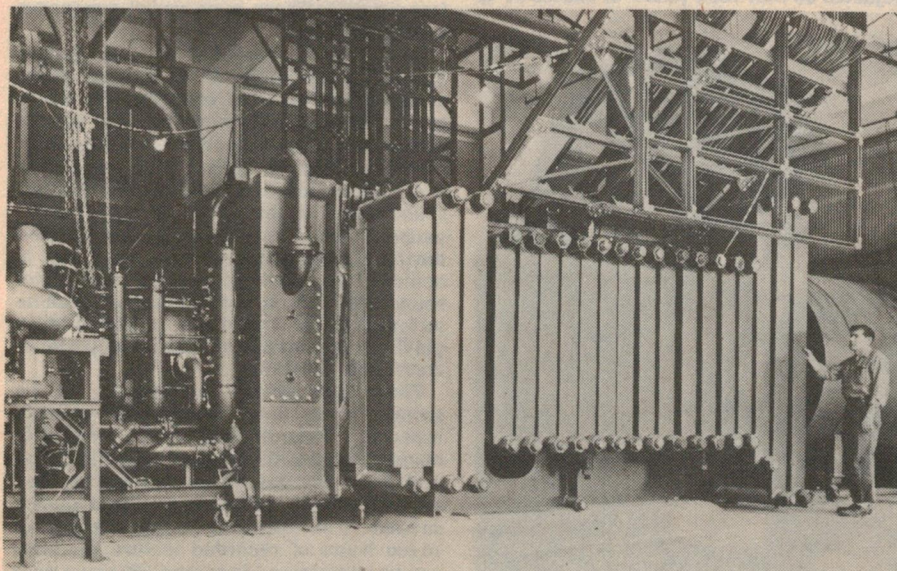
generator this year, move to a 1MW generator in three or four years, and have a 20MW pilot plant in operation by 1982. That would cost about \$45 million, and would have liquid-metal MHD plant ready by the time the first fast breeder is scheduled to go on line. The open-cycle people have their own timetable, one that was presented to a congressional committee last year.

Open-cycle researchers have put forward two basic proposals in their development timetable: first, that the US support basic MHD research at a level of about \$8 million a year; and second, that planning for a 50MW pilot plant, to become operational by 1976, should begin immediately.

It is envisaged that the basic research program would include such efforts as the conversion of a wind tunnel at the USAF Engineering Development Center in Tennessee into a 50MW MHD generator that would operate in 10-second bursts to test new ideas. This program could also include the construction of a 20MW channel by Avco for the Soviet Union. The Soviets say that if the US will build the channel, they'll test it under operating conditions.

The proposed 50MW pilot plant is intended to provide engineers with the necessary data to enable them to begin planning a 1,000MW MHD plant which would go on line by 1982. Present day concepts envisage that the plant would consist of a MHD "topping plant" that would extract perhaps 20 percent of the fuel's energy. Spent gas from the MHD section would then go to a conventional steam generator that would extract 40 percent of the fuel energy. Total operating efficiency would thus be about 55 to 60 percent.

It is estimated that the total cost of the entire MHD development program will be in the region of \$560 million — a figure representing the approximate cost of one large conventional generating plant, as MHD experts are quick to point out. If MHD works, the savings in fuel could run into billions of dollars. Just how many billions no one knows as the price of all fuels seems to be going up indefinitely. It only remains for us to put up the research and development money to get the answer.



The Avco Everett Mark V, which generated 32MW of electricity in brief bursts, holds the world MHD record. The device was dismantled several years ago after the completion of experiments, providing valuable data for future designs.

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Squeezing speech aids learning process

Anyone who has ever worked with pre-recorded audio tapes containing oral communications will realise that the fatigue factor in listening to these tapes is high, especially when they contain lecture material. In such circumstances, anything that will heighten listener interest, and at the same time save time and money, will be invaluable. The VOCOM-1 speech compressor / expander described here may be the answer.

Time shortened or time compressed speech has been of academic interest for many years. The principle behind this concept is simple: the average person can understand speech which is much more rapid than can be produced by normal speaking. Because his understanding rate is potentially greater than the delivery rate, a person listening to normal speech will tend to let his mind wander off the topic, thereby missing important parts of the information conveyed. The ideal situation would be, therefore, to introduce some form of speech compression to match the understanding rate of the listener, and at the same time retain the natural voice quality.

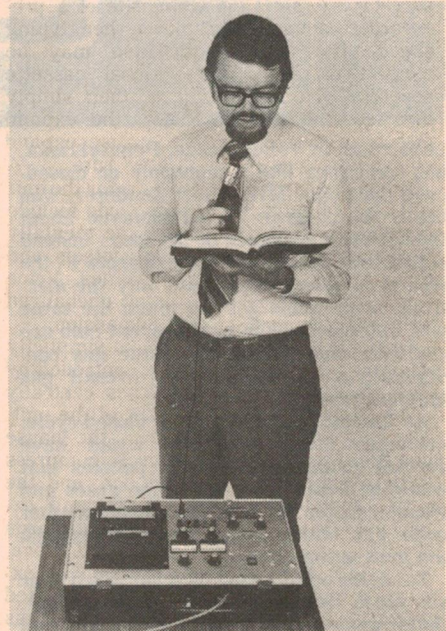
These requirements have been fully realised in the design of the VOCOM-1 speech compressor / expander. Developed by PKM Corporation of St Paul, Minnesota, the unit is the result of many years of research by PKM into the problems and techniques of speech compression. In addition, VOCOM-1 is simple to use and costs far less than previous speech compressors.

Earlier speech compressors discarded portions of speech at regular intervals, disregarding completely the contents of the

discarded segments. This resulted in chopped speech where intelligibility dropped rapidly as the listening time was reduced. The VOCOM-1 unit functions somewhat differently by employing a technique called selective deletion. Instead of discarding segments of speech, the unit shortens the pauses taken between words in the course of normal conversation.

A person making a conscious effort to speak rapidly not only shortens the pause duration between words, but also tends to shorten vowels. This facility has also been incorporated into the VOCOM-1, and may be used in conjunction with the pause compression facility. The pause compression may be adjusted so that the shortest pause retained on compression is 20 milliseconds (maximum compression) to 1.0 second (minimum compression).

The VOCOM-1 unit is also capable of producing time expanded speech, ie, speech that is much slower than usual. This is accomplished by automatically sensing when a pause occurs during speech, and inserting an additional pause of controlled duration. The duration of this pause may be adjusted so that each pause in excess of 40

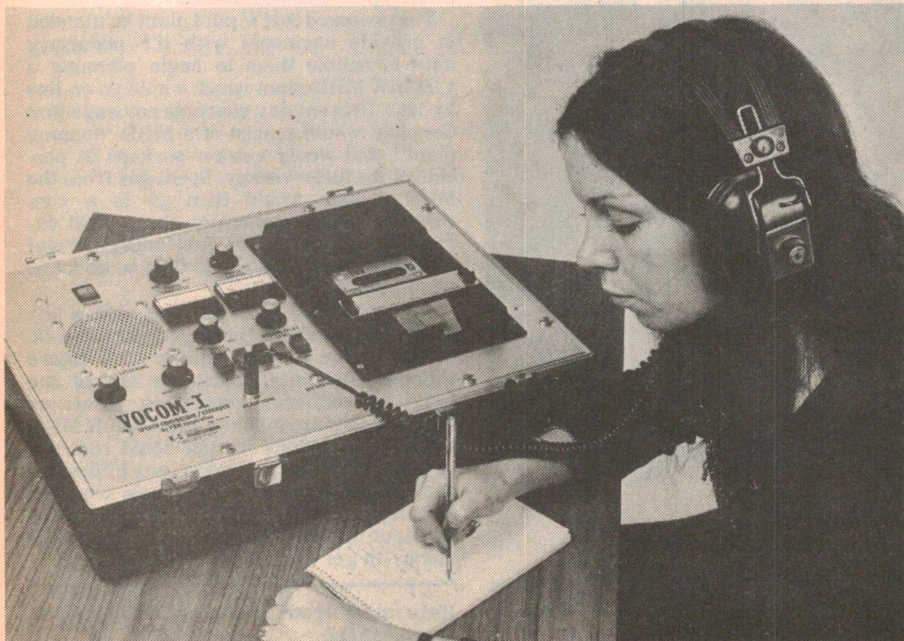


The VOCOM-1 unit is eminently suitable for compressing audio lecture material (above), and for dictation purposes when operated in the compression mode (lower, left).

milliseconds on playback expand is increased between 100 milliseconds (minimum) to 500 milliseconds (maximum). There is no vowel expansion capability.

Both speech compression and speech expansion are achieved by automatically stopping the cassette transport for short pre-determined periods of time. For speech compression, the machine automatically detects a pause during the recording process and stops the cassette until the next sound is spoken, thereby deleting part of the pause. Vowel compression is also effected during the recording process, and this is achieved by deleting part of the vowel sound. For speech expansion, the machine automatically senses a pause during playback and inserts an additional pause of controlled duration.

There are several advantages to be gained from time compressed speech, especially when the text is compressed to about 60-70pc of the original time. The first and most obvious advantage is the time saved (30-40pc), resulting in direct money savings. For example, a tape library of 10,000 hours of recorded lecture material can be compressed to some 6,500 hours with a corresponding saving in the cost of tape. Secondly, time compressed speech attracts greater listener interest and concentration, thus making the unit ideally suited to



educational institutions using pre-recorded lecture material.

It is also claimed that time compressed speech makes the learning process more efficient, by matching the delivery rate with the listener's ability to absorb information. This obviously has important application in the areas of self-study via pre-recorded audio tapes, sales training programs, and oral communications via tape in general.

While the average listener would find time expanded speech boring, it does have certain specialised applications. For example, the expand facility allows a secretary to slow the word rate of a pre-recorded dictation to match her typing speed. The original dictation may be carried out on a conventional cassette recorder. The recording is then simply inserted into the VOCOM-1, the expand button depressed, and the pause expand control adjusted to the desired rate.

Other specialised applications for the unit when operated in the expand mode include remedial speech training for the mentally retarded and those with speech defects, and the learning of foreign languages. Voice quality, tone, and pitch remain unchanged with both compression and expansion.

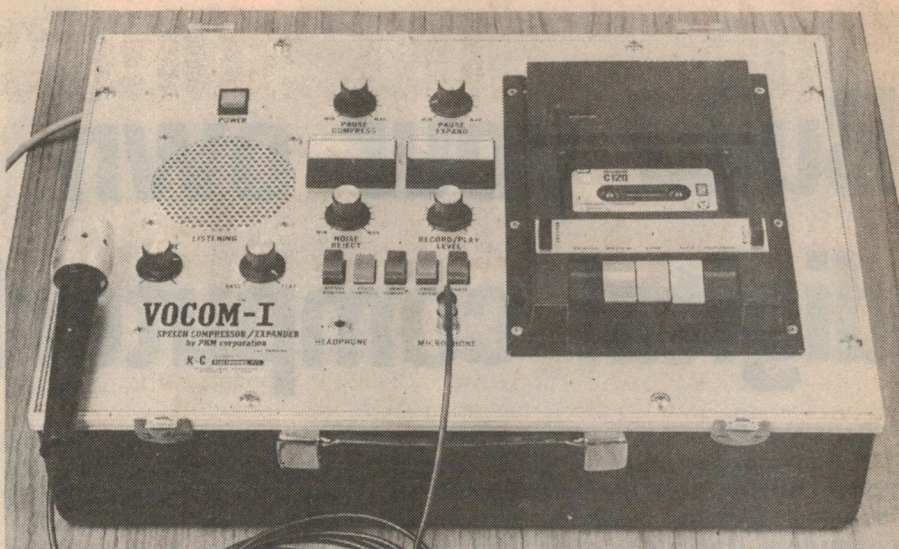
Operation of the VOCOM-1 is simplicity itself. Operational modes are controlled by five push on/push off switches centrally grouped and towards the front of the unit. These are the record switch, the pause compress switch, the vowel compress switch, the pause expand switch, and the pause switch. The compression and expansion control knobs are located towards the top of the unit and, as indicated above, allow the amount of compression or expansion to be controlled. A meter, located directly beneath the pause compress control, indicates the amount of expansion or compression in percent. Adjacent to the expansion/compression meter is a large VU meter.

Immediately below the compression/expansion meter is the noise reject control. This control is used in the compression mode when recording against background noise, thus setting a threshold on the minimum signal level at which this mode will operate. Other control facilities include those normally found on a conventional cassette recorder, including a volume control, tone control, recording level control, a 3-digit counter, tape transport controls and the headphone and microphone jacks.

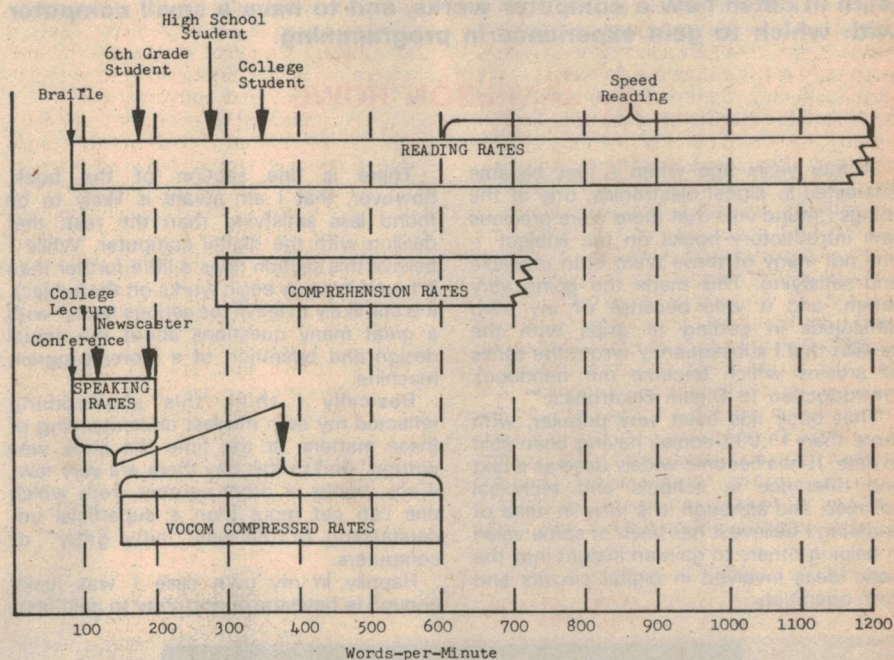
One facility not found on a conventional cassette deck is the review control, which is located together with the tape transport controls. When the machine is operated in the playback mode, the review control will backspace the cassette whilst depressed, and return to playback when released. This facility should be particularly valuable to the secretary typing from a speech expanded recording should it be necessary to review a few words that may have been missed. The student listening to pre-recorded lecture material in the speech compression mode will also find this facility useful.

Physically, the VOCOM-1 unit is quite large, the approximate dimensions being 19 x 36 x 49cm (including the carrying case). The unit is mounted in a sturdy, vinyl covered aluminium carrying case and weighs approximately 7.7kg (17lbs).

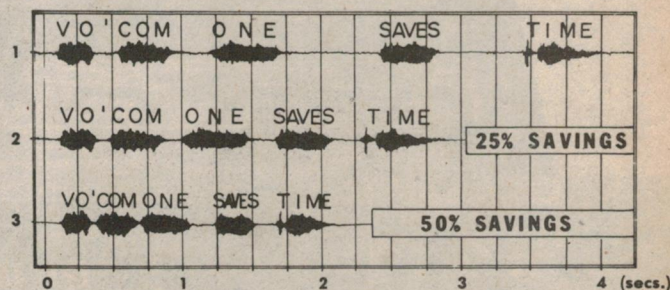
Our own experiences with the unit showed that 100pc intelligibility could be maintained with the compression set as low as



Shown above is a close-up view of the VOCOM-1 unit, while below is a graph depicting the reading, comprehension and speaking rates of various groups together with speech compression rates.



The VOCOM-1 unit compresses speech by shortening the duration of natural pauses and by shortening the vowel sounds.



60pc of the normal time. However, when compression was increased to 40pc (by employing both pause compression and vowel compression) the text became quite difficult to follow, indicating that some listening practice would be required to maintain intelligibility at this level.

Taken overall though, we found the text a great deal more interesting to listen to when compressed to levels of the order of 60-70pc of the normal time. The VOCOM-1 certainly

captured the attention of all staff members, and all agreed that one's concentration improved when the unit was operated in the compression mode. A further bonus is, of course, the considerable time saving effected by time compressed speech.

For further information regarding the VOCOM-1 unit contact the Australian distributors, K.C. Electronics Pty Ltd, 239 Scenic Drive, Merewether, NSW 2291. Telephone 63 2411. (G.S.)

An E-A world exclusive project:

Build your own digital computer!

This is the first of a series of articles describing a complete general purpose stored-program digital computer. Designed specifically for home construction, the computer has an instruction repertoire which includes all of the basic instructions available on most modern minicomputers. Despite this the cost has been kept down to a level far lower than any commercial machine, and the construction made very straightforward by having virtually all the wiring on printed boards. These features should make it an ideal project for anyone keen both to learn in detail how a computer works, and to have a small computer with which to gain experience in programming.

by JAMIESON ROWE

A few years ago when I first became interested in digital electronics, one of the things I found was that there were precious few introductory books on the subject — and not many of these were both readable and satisfying. This made the going very tough, and it was because of my own difficulties in getting to grips with the subject that I subsequently wrote the series of articles which became our handbook "Introduction to Digital Electronics."

That book has been very popular, with more than 11,000 copies having been sold to date. It has become widely used as a text and reference in schools and technical colleges, and although it is now in need of updating I believe it has been of some value in helping others to gain an insight into the basic ideas involved in digital circuits and their operation.

There is one section of the book, however, that I am aware is likely to be found less satisfying than the rest: that dealing with the digital computer. While I believe this section goes a little further than is found in many basic works on the subject, it is still likely to leave the serious reader with a great many questions about the actual design and operation of a stored-program machine.

Basically I think this shortcoming reflected my own modest understanding of these matters, at the time the book was written. And to this day there are very few, if any, books or other sources from which one can get more than a superficial understanding of the real "nitty gritty" of computers.

Happily in my own case I was lucky enough to have the opportunity to gain first-

hand insight into computer operation and programming. Thanks to the generosity of one of our parent companies, John Fairfax and Sons Ltd, and the friendly co-operation of their EDP Managers and staff, I was able to spend many hundreds of lunch-time hours writing programs and running them on their Digital Equipment PDP-8 minicomputers.

It was this extremely valuable experience which allowed me to finally grasp many of the points about computer operation which had never quite emerged from reading books. Truly, there is no real substitute for "hands on" experience, at least as far as the basic operation of computers is concerned!

However there was still one whole area into which even this experience had not provided insight, even though it had laid a very worthwhile foundation: the actual electrical design of a computer. And being an incurably inquisitive person, this naturally became the most intriguing aspect of all.

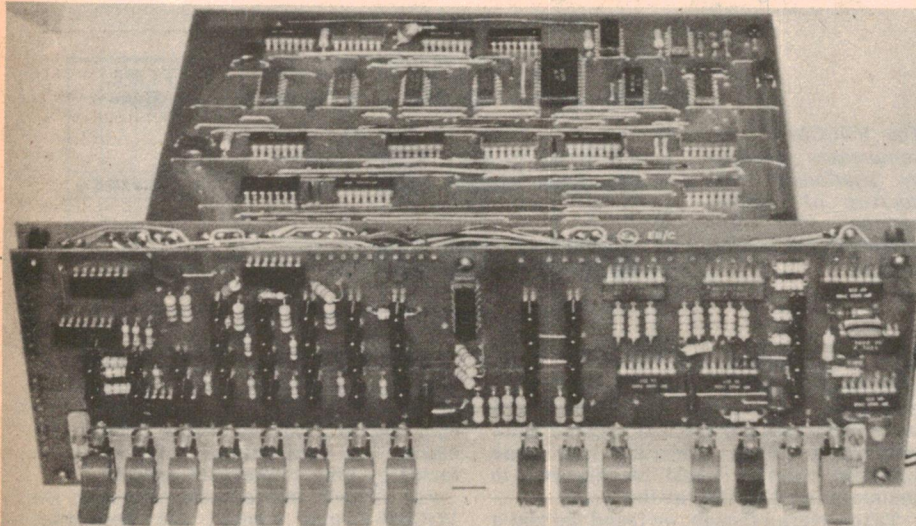
If, like myself, you've ever tried to get hold of the circuits of a minicomputer, with a view to finding out just how they function in fine detail, you'll probably agree that this is a well-nigh impossible task. I have never found such circuits in any textbook, nor have I been able to find them in any of the voluminous manuals which seem to accompany the machines themselves. I can only assume that the manufacturers prefer to keep the exact details to themselves and their servicing people.

There seemed to be no option, then, but to sit down with some modern digital IC data books, and design my own small computer based purely on a knowledge of general operating principles.

This, then, is the story behind the project itself. It has been a very interesting and challenging one, and I believe that it has taught me a great deal about the general principles of small computer design. I hope that at least some of these rewards may be passed on to readers, as a result of its description. I have spent considerable effort in trying to ensure that construction of the unit itself will present as few problems as possible, and will be doing my best in these articles to help the reader get the most benefit from the overall exercise.

But enough of this preamble. By now, the reader is no doubt wondering if I am ever going to get around to introducing the gadget itself!

Perhaps the best way to start is by describing the computer as a scaled-down version of the Digital Equipment PDP-8 machine — at least, in terms of its instruction repertoire and basic console layout. It has the same eight basic types of instruction, and for convenience I have used the same mnemonic names and similar coding.



A view of the "works" of the computer, taken before it was fitted into the case. Virtually all of the wiring is taken care of by the PC boards.

This has not been done purely because of my own initial experience with the PDP-8 family of machines, nor out of a simple desire to flatter the Digital Equipment people — although they have undoubtedly played, and are still playing, a leading role in developing minicomputer technology. While the design no doubt reflects in good measure my familiarity with these machines, and I am happy to pay tribute to the eminence of DEC, this superficial plagiarism has been done for a far more down-to-earth reason.

The fact is that Digital Equipment has led in the minicomputer field right from the start, and there are many more DEC machines in use than any other. Therefore the chances are great that if the reader, after building my little computer and gaining experience with it, has the opportunity to graduate to a commercial machine, it is likely to be a DEC machine. By making the operation of my machine as similar to a PDP-8 as possible, I hope that this transition to bigger and better things will be made easier.

I should perhaps add that most minicomputers have a great deal in common, so the fact that our machine is styled on the PDP-8 should not be seen as making it too specialised. In fact if the reader builds up this machine and uses it to get a solid grounding in basic computer operation and programming, he or she should find very little difficulty in making the transition to almost any brand of commercial minicomputer.

Essentially, then, this computer is rather like a PDP-8 and other modern minicomputers, except that it is a good deal smaller. Not so much in terms of physical size, because the latest generation of minicomputers are quite small themselves. The contrast is more in terms of circuit complexity, which has been scaled down both to reduce the cost and to bring the whole size of the project within the scope of a single individual.

Probably the most obvious difference is in terms of memory size, and this is because the memory is the most costly part of any computer. Whereas most modern minicomputers have a memory with at least a thousand or so storage locations, the memory of this machine has only a modest thirty-two.

While this much smaller memory capacity would make the machine of very limited use in practical computing applications, don't assume from this that it is purely a toy. A memory of 32 locations is entirely adequate for demonstrating virtually all aspects of basic computer operation and programming.

In fact, it is surprising just how complex and powerful a program one can fit into a memory this size, as I have been discovering! And in a very real sense, the small size of the machine's memory makes programming that much more of a challenge. It is relatively easy to write a program to perform a certain task, as any experienced programmer will tell you — the real trick is to achieve this end as economically as possible.

With a memory of only 32 locations, one cannot help being steered automatically in the direction of economic programming!

This is not to say, of course, that a larger memory would not have been desirable. A larger memory would certainly broaden the practical scope of the machine, and when the description of the basic machine and its

About this unique project . . .

Our description of this project is, we believe, a unique and historical event in the development of popular electronics journalism. To the best of our knowledge it is the first time, anywhere in the world, that a complete general purpose stored-program digital computer has ever been described for home construction.

We believe it is particularly fitting that Electronics Australia is the first magazine to publish such a project. As one of the longest established electronics magazines in the world, it has always played a leading role in the do-it-yourself project and learn-while-you-build tutorial fields, and this project marks a milestone in both these areas.

We are also proud that the project has been developed wholly by Editor Jim Rowe, a member of the E-A staff for nearly fifteen years. Although the project has been developed almost entirely in his own time as a "labour of love", it continues the tradition which we have carefully built up over many years: that of describing as many projects as possible which have been developed by our own staff, thoroughly tested, and which therefore may be tackled by readers with confidence.

We believe this policy has played an important role in establishing E-A as the leading electronics magazine in Australia, and one of the leading magazines in the world.

This project will, we believe, have a particularly strong appeal not only for individuals, but also for high schools, technical colleges and other training establishments. This is because it provides both a means of learning in detail the exact operation of a modern stored-program digital computer, and also the opportunity (when the computer is completed) of gaining direct experience of computer operation and basic programming.

There have been many books published which cover the general field of digital electronics, our own "Introduction to Digital Electronics" included. Similarly there have been numerous logic training devices described, like our own Logic Trainer of March and April 1973. However apart from giving the enthusiast a general idea of the basic modules used in digital computers — such as shift registers, binary adders, and logic gates, these books and devices generally reveal little of how a digital computer is actually put together, and the detail of how it works.

To be sure, one is told that these basic modules are used to make up the broad sections of a computer, such as the "arithmetic unit", the "control unit" and the "memory unit". But little has been said of just what these sections comprise, and exactly how they interact with one another to produce an operating stored-program machine.

It was because Jim Rowe himself found these intriguing "fine details" of computer design and operation inadequately explained, that he decided many months ago to tackle the design and construction of a small computer for himself. He believed that by doing this, he would not only learn these elusive secrets for himself, but would also as a result be in the ideal position to pass them on to others.

In addition, there has been the second strong motivation for describing a low cost do-it-yourself computer: the fact that, for the first time, this will enable almost anyone to sit down with a computer and obtain the "hands-on" experience which is so essential for a full understanding of how these revolutionary machines work.

As anyone who has ever played with a computer will tell you, there is absolutely no substitute for this sort of experience. Until one has actually played with a computer, these machines will always remain partly clouded by an element of awe and disbelief.

Modern minicomputers are very much lower in cost than the first computers, but they are still rather too costly to make them sufficiently accessible to all who really need this "hands-on" experience: the private individual, the school pupil, and the college student.

It is our firm belief that Jim Rowe's little "EDUC-8" computer will play an important part in bringing computer technology down to these very people. For it is not only a do-it-yourself construction project but a means of providing a small, yet fully operational computer within the reach of almost everyone's pocket.

peripheral devices is completed, I plan to look at the possibility of enlarging the machine in this way. But unless memory devices fall dramatically in cost, this will probably involve a significant increase in the overall cost of the machine, so that for the present I must ask the reader to accept my assurance that the present memory size represents an entirely acceptable place to start.

Apart from the memory size, there are two other main ways in which the computer is scaled-down in comparison with a typical commercial minicomputer. One is the word length, or the size of the binary numbers used in the machine to represent both instructions and data numbers. Whereas most commercial minicomputers have a word length of either 12 or 16 binary digits or "bits", in this case the word length is only 8 bits.

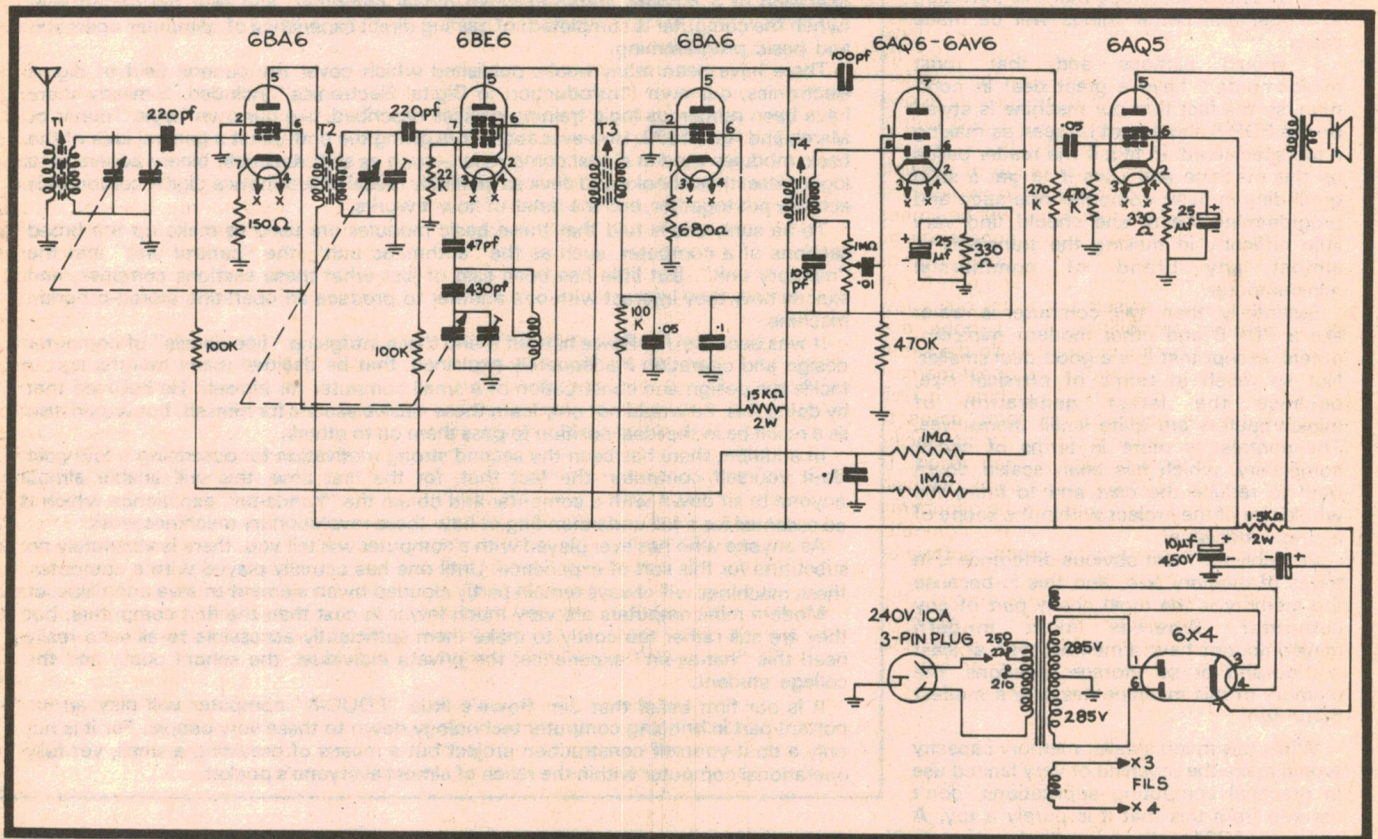
Again, this has been done to reduce both cost and circuit complexity. The main

penalty arising from the reduced word length is that the machine can normally deal with only modest numbers — between plus 127 and minus 128, inclusive. The relatively short word length has also made it necessary to reduce the number of augmented operate instructions, as will be explained later. I believe both these limitations are acceptable in view of the savings made possible.

The other main way in which the machine has been scaled down is in terms of the number of input and output devices or "peripherals" which it is designed to communicate with at any one time. Whereas many modern minicomputers are designed to "interface" with up to as many as 32 or 64 input and output devices at any one time, this machine will only interface with up to two of each — four in all.

This is a very minor limitation in a machine designed mainly as an educational tool, I believe, because the need to deal with large

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DIGITAL COMPUTER

numbers of peripheral devices is largely confined to practical data logging applications. Just about all of the basic principles involved in input-output transfer can be demonstrated using two input and output devices, and in fact more devices would probably only confuse the situation.

In any case the machine has been arranged so that the input and output devices simply connect to it via sockets on the case rear. If a total of more than four peripheral devices are built up or acquired, it is therefore quite easy to substitute devices as needed. Only four devices may be plugged in at any one time, that is all.

What peripheral devices may be used with the computer? Within reason, almost anything. As part of the basic description, I hope to describe a suitably simple and low cost input keyboard unit, together with one or two appropriate output display units. After this I hope to give details for interfacing with punched-paper tape readers and punches. It may also be possible to give details of other types of input and output devices, if opportunity permits.

To a large extent, the range of possible input and output devices to which the computer may be connected will be limited mainly by your imagination. There seems no fundamental reason why it could not be hooked up to all sorts of equipment, for all sorts of jobs. I myself aim to try out a few interesting possibilities, and I hope that readers will be encouraged to do the same.

Of course, in view of the modest memory capacity of the basic machine, it will probably be necessary in some cases to come up with some pretty fancy interfacing circuitry to achieve the desired result. In other words, to make use of some relatively high-powered "hardware" in the peripherals to make up for the fact that the computer itself can't accommodate much "software" — ie, much program.

Still, if you're at all adventurous, this should simply add to the challenge. My main aim in these articles will be to help you gain the necessary expertise, so that can go wherever your imagination leads.

At this stage I should perhaps devote a few words to explain the basic electrical and physical construction of the computer.

All of the main circuitry of the machine is designed around TTL digital integrated circuits (ICs). There are a number of medium-scale or MSI devices, used mainly for the various registers, and one large-scale or LSI device — the memory IC. Apart from these, the remaining devices are all low cost "garden variety" 7400 devices. All should be readily available.

No doubt some will wonder why I have not used one of the new "microprocessor" LSI devices as the heart of the machine. This would have reduced the number of ICs used, to be sure; in fact the whole computer would probably have fitted on a single small printed board. However I decided against this approach quite early in the development of the project, for two reasons which I believe are conclusive.

The first is cost. Microprocessor chips are still quite costly; at the time of writing they sell for about \$110 each. By the time one adds a memory device and the additional circuitry required to interface with a control console and input-output devices, this would make the cost of the resulting

machine considerably higher than the one presented here. And I don't know about the reader, but I myself would probably be far too nervous to play around with any single IC costing more than a hundred dollars!

But quite apart from the cost, there is the matter of teaching potential. A microprocessor chip is ideal for manufacturers wanting to build a computer into their systems as an integral part, but by its very nature it is not at all suitable for learning how a computer functions. With virtually all of the computer hidden away inside a 40-pin IC package, all of the real mysteries remain the property of the IC maker.

As it stands, there are a total of 96 ICs in the basic computer, most of these being low cost 7400 series devices. Some 86 are used in the basic processor and memory sections, while the remaining 10 are used in the internal input-output interface circuitry.

If this number seems a bit large, consider that the ICs probably incorporate something like 7,000 identifiable transistor elements. Small wonder that this computer project just wouldn't have been worth considering before MSI and LSI devices became a reality about two years ago.

Even with only 96 ICs to worry about, of course, the computer is still not a small project by do-it-yourself standards. If it had to be wired up in the old fashioned way, it would be an enormous job, and I doubt whether anyone would have been even remotely interested.

With this in mind I have designed the unit so that virtually all of the wiring is performed by printed boards. There are eight boards in all making up the basic computer: a board which takes care of all the front panel or "console" wiring, an interconnection or "mother" board, and six plug-in boards which make up the various functional parts of the machine.

As the mother board performs virtually all of the interconnections between the sockets for the plug-in boards, the actual hard wiring involved in building the computer is very small. Essentially it amounts to little more than making the few dozen interconnections between the mother and front panel boards, together with the power supply and input-output connector wiring.

I should mention here that to keep the cost down, I have used only single-sided printed boards for the project. This inevitably means that wiring-up each board involves fitting a number of wire links, in addition to fitting the IC's and the few other components. While this approach would not be appropriate for commercial manufacture, where the time needed to fit links might well prove more expensive than double-sided

boards, I believe it is the right choice where a home construction project is concerned.

The saving in board cost is quite dramatic, and for the enthusiast should far outweigh the small increase in assembly time and tedium. At least, I hope so.

The complete computer is housed in a metal case measuring about 30 x 10 x 35cm (WxHxD), or about 11 1/2 x 4 x 14 inches. The basic machine draws about 3 amps at 5 volts DC, or about 15 watts. However I have designed the power supply so that it can supply power to a number of peripherals, to simplify interfacing. As a result the total power consumption may in practice rise as high as 60 watts or so.

When one considers that this is probably still going to be less than the power consumed by the light bulb in the room you are using the machine, it provides dramatic evidence of the advances which have been made in computer technology over the last few years. The first computers were probably somewhat simpler than this little machine, yet occupied a complete room and needed their own power sub-station!

For the benefit of those who would like to know a little bit more about the computer they would end up with if they embark on this project, I have prepared a brief specification which is shown in the box panel. At this stage the specification may not mean much to you, however, because it really presupposes a knowledge of basic computer operation. For most readers, gaining this very knowledge will be the whole point of the exercise, and if they knew now they wouldn't be bothering.

The main idea behind giving it here is to show that the computer is quite a capable little machine, despite the fact that it has been scaled down for home construction. It has just about all the basic capabilities found in modern computers, and is therefore able to demonstrate most aspects of computer operation, although for the present you'll probably have to take my word for this.

Incidentally, when the basic machine has been described, I will then spend some time discussing programming. So you need not be concerned that having built the computer, you won't know what to do with it. Naturally you won't become an expert programmer, but I hope you will emerge from all this with a sound basic grounding — if you can stick with it.

Two aspects of the project remain to be discussed in this introduction, I think. One is the name we have given the computer. Like all good computers, it must have an impressive-sounding name — that's traditional. In this case we came up with the name "EDUC-8", and our excuse for this

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- 82 1972 IC Unit (E / T).
- 83 Simple 5V 1A Unit.
- 84 Simple 3-6V 3.5A Unit.
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- 86 Reg 0-30VDC at 3A O / L Protected.
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- 90 —

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- 104 V.H.F. Powermatch.

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- 106 S.W.R. Reflectometer.
- 107 R.F. Impedance Bridge.
- 108 Signal Injector.
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- 110 Digital Freq Meter.
- 111 Simple Logic Probe.
- 112 Frequency Counter & DVM Adaptor.
- 113 Improved Logic Probe.
- 114 Digital Logic Trainer.
- 115 Digital Scaler / Preamp.
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- 118 Solid State Signal Tracer.
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- 125 Model Control with Simulated Inertia.
- 126 Hi-Power unit 1968.
- 127 Power Supply Unit.
- 128 SCR-PUT Unit 1971.
- 129 SCR-PUT Unit with Simulated Inertia 1971.
- 130 Electronic Steam Whistle.
- 131 Electronic Chuffer.

TV INSTRUMENTS

- 134 Silicon Diode Sweep Gen.
- 135 Silicon Diode Noise Gen.
- 136 Transistor Pattern Gen.
- 137 TV Synch & Pattern Gen.

VOLTAGE / CURRENT CONTROL UNITS

- 142 Auto Light Control.
- 143 Bright / Dim Unit 1971.
- 144 S.C.R. Speed Controller.
- 145 Fluorescent light Dimmer.
- 146 Autodim-Triac 6 Amp.
- 147 Vari-Light 1973.
- 148 Stage, etc. Autodimmer 2KW.
- 149 Auto Dimmer 4 & 6KW.

RECEIVERS — TRANSMITTERS — CONVERTERS

- 153 3 Band 2 Valve.
- 154 3 Band 3 Valve.
- 155 1967 All Wave 2.
- 156 1967 All Wave 3.
- 157 1967 All Wave 4.
- 158 1967 All Wave 5.
- 159 1967 All Wave 6.
- 160 1967 All Wave 7.
- 161 Solid State FET 3 B / C
- 162 Solid State FET 3 S / W
- 163 240 Communications RX.
- 164 27 MHz Radio Control RX.
- 165 All Wave IC2.
- 166 Fremodyne 4-1970.
- 167 Fremodyne 4-1970.
- 168 110 Communications RX.
- 169 160 Communications RX.

- 170 3 Band Preselector.
- 171 Radio Control Line RX.
- 172 Deltahet MK2 Solid State Communications RX.
- 173 Interstate 1 Transistor Receiver.
- 174 Crystal Locked H.F. RX.
- 175 E / A 130 Receiver
- 176 E.A. 138 Tuner / Receiver.
- 177 Ferranti IC Receiver.
- 178 Ferranti IC Rec / Amp.
- 179 7 Transistor Rec.
- 180 —
- 181 —

TRANSMITTERS

- 182 52MHz AM.
- 183 52MHz Handset.
- 184 144MHz Handset.

CONVERTERS

- 187 MOSFET 52MHz.
- 188 2-6 MHz.
- 189 6-19 MHz.
- 190 V.H.F.
- 191 Crystal Locked HF & VHF.

AMPLIFIERS PREAMPS & CONTROL UNITS

- 194 Mullard 3-3.
- 195 Modular 5-10 & 25 Watt.

STEREO

- 196 1972 PM 129 3 Watt.
- 197 Philips Twin 10-10W.
- 198 PM 10 + 10W.
- 199 PM 128-1970.
- 200 PM 132-1971.
- 201 ETI-425 Amp & Preamp.

ETI-425 Complete System.

- 203 ETI-416 Amp.
- 204 PM 136 Amp 1972.
- 205 PM 137 Amp 1973.

GUITAR UNITS

- 209 P / M 125 50W.
- 210 E / T 100 100W.
- 211 P / M 134 21W.
- 212 P / M 138 20W.
- 213 Modular 200W.
- 214 Reverb Unit.
- 215 Waa-Waa Unit.
- 216 Fuzz Box.

PUBLIC ADDRESS UNITS

- 219 Loud Hailer Unit.
- 220 P.A. Amp & Mixer.
- 221 P / M 135 12W.
- 222 Modular 25W.
- 223 Modular 50W.

CONTROL UNITS

- 225 P / M 112.
- 226 P / M 120.
- 227 P / M 127.

MIXER UNITS

- 229 FET 4 Channel.
- 230 ETI Master Mixer.
- 231 Simple 3 Channel.

TUNER UNITS

- 232 P / M 122.
- 233 P / M 123.
- 234 P / M 138.
- 235 Simple B / C.

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- 237 Silicon Mono.
- 238 Silicon Stereo.
- 239 FET Mono.
- 240 Dynamic Mic Mono.
- 241 Dynamic Mic Stereo.
- 242 P / M 115 Stereo.
- 243 —

MISCELLANEOUS KITS

- 244 Geiger Counter.
- 245 Direct Reading Impedance Meter.
- 246 —

- 247 Electronic Anemometer.
- 248 Simple Proximity Alarm.

- 249 Pipe & Wiring Locator.
- 250 Resonance Meter.
- 251 Electric Fence.
- 252 Metronome Ace Beat.
- 253 Transistor Test Set.
- 254 Electronic Thermometer.

- 255 Flasher Unit.
- 256 Lie Detector.
- 257 Metal Locator.
- 258 Stroboscope Unit.
- 259 Electronic Canary.

- 260 240V Lamp Flasher.
- 261 Electronic Siren.
- 262 Probe Capacitance Meter.

- 263 Moisture Alarm.
- 264 AC Line Filter.
- 265 Proximity Switch.
- 266 Silicon Probe Electronic Thermometer.

- 267 Transistor / FET Tester.
- 268 Touch Alarm.
- 269 Intercomm Unit.

- 270 Light Operated Switch.
- 271 Audio / Visual Metronome.

- 272 Capacitance Leakage Checker.
- 273 Audio Continuity Checker.

- 274 Bongo Drums.
- 275 Simple Metal Locator.
- 276 Keyless Organ
- 277 Musiccolour.

- 278 Stereo H / Phone Adapter.
- 279 Attack / Decay Unit.

- 280 Tape Recorder Vox Relay.
- 281 Tape Slide Synchroniser.

- 282 Tape Actuated Relay.
- 283 Auto Drums.
- 284 IC Vol Compressor.

- 285 Audio Attenuator.
- 286 Thermocouple Meter.
- 287 Door Monitor.

- 288 Earth "R" Meter.
- 289 Shorted Turns Tester.
- 290 Zener Diode Tester.

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SPECIFICATION OF THE COMPUTER

The machine is a complete stored program general purpose digital computer. Memory storage is provided by means of a bipolar static random-access integrated circuit (RAM), organised to have a capacity of 32 locations.

Both instructions and data words use a format of 8 bits.

Almost all processing is performed serially, with alternative clock rates of approximately 500kHz and 2Hz. Instruction cycle times are constant at either speed, at approximately 96 microseconds and 24 seconds respectively. Operation may be either continuous or on a single instruction basis, as desired.

There are five main registers, comprising the program counter (PC), the accumulator (AC), the memory address register (MA), the memory buffer register (MB) and the instruction register (IR). The front panel of the machine is also provided with a switch register for manual loading of addresses, instructions and data.

Six types of memory reference instruction are provided, consisting of logical AND (AND), binary addition (TAD), increment and skip if zero (ISZ), deposit and clear accumulator (DCA), unconditional jump (JMP) and jump to subroutine (JMS). A single address format is used for these instructions, but both direct and indirect addressing are available.

Eight augmented operate (OPR) instructions are provided, comprising increment accumulator (IAC), complement accumulator (CMA), clear accumulator (CLA), rotate accumulator 1 bit right (RAR), rotate accumulator 1 bit left (RAL), skip on zero accumulator (SZA), skip on minus accumulator (SMA) and halt (HLT). A number of these instructions may be combined, for programming economy.

Three augmented input-output transfer (IOT) instructions are provided, each of which may be arranged to specify either an input or output device, and one of two possible devices in each category. The instructions are skip on device flag (SKF, SDF), transfer data between device buffer and accumulator (KRS, LDS), and reset device flag (RKF, RDF). The second and last of these may be combined for programming economy.

The contents of all registers are displayed on the front of the machine by means of light-emitting diodes (LEDs), allowing the operation to be readily followed.

Power consumption of the basic machine is approximately 15 watts, but rises to approximately 60 watts with some combinations of input-output devices.

somewhat transparent pun is that the first part stands for "Educational Digital micro (u) Computer", while the figure 8 represents either the number of basic instruction types, or the word length, or both!

Anyway, it IS a small or "micro" computer, and we hope it will prove useful as an educational tool. It must have some sort of name, and EDUC-8 is probably as good as any.

Finally, there is the matter of cost. You have probably been wondering if I was ever going to be specific about this, and the truth is that I have deliberately left it until now to give you a chance to put the project in perspective.

It is very difficult to be accurate about cost, because as most readers will be well aware, prices of electronic components are fluctuating all the time. About the best I can do is tell you that as far as we can estimate, the complete basic computer will probably cost you about \$300 — maybe a little more, quite possibly a bit less.

Don't forget that because the project is built on a number of boards, you can build it up progressively a module at a time, and distribute the outlay over a period of time. We will be describing the project with this approach specifically in mind, in fact, as quite apart from the cost angle there are other advantages in tackling the project in stages.

With a project this size there is a lot to be said for building up the key sections one at a time, and checking them out individually before the final assembly as a system.

Well, that's the basic story on this new project of ours. I hope some of my own enthusiasm for it has rubbed off, and that by this stage some of you will be champing at the bit.

Before I close this introduction, I must give grateful thanks to the many people who have helped me very considerably in the development of the project. I am indebted to

John Houston and Val Rech of Fairchild Australia, Ron Bell of RCS Radio, Doug Evans of Ferguson Transformers, Peter Carter of A & R Soanar, David Segal of Philips Elcoma, Brian Cleaves of Plessey Australia, Norm Volkman of Wardrope and Carroll Fabrications, and Erle Goodwin of General Electronics Services — to name but a few of the many who generously contributed both advice and samples. I hope that those not named in the foregoing will please assume, rightly, that this is purely because of lack of space.

There are also my fellow staff members at E-A, who have been very tolerant of my involvement with and enthusiasm for the project. I must particularly express thanks to Bob Flynn, who has been of great help in the preparation of the printed board patterns.

And last, but by no means least, I must express my very grateful thanks to my wife Laraine, for putting up with the long lonely nights and weekends when I have been either submerged in the workshop, or present physically but almost constantly preoccupied with a logic problem or printed board pattern. The things we electronics addicts inflict on our loved ones!

STOP PRESS!

Just as this issue was going to press, an advance copy of the July issue of the US magazine "Radio-Electronics" reached us. In it they give details of Mark-8, a minicomputer based around the Intel 8008 microprocessor IC and 1101 memory ICs. Our design is not the first, then, as it transpires — we were beaten by a few weeks!

Ah well, such is life. Still, readers will now have a choice of two computer designs, each with rather different emphasis.

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Advanced electronics in Polaroid SX-70 camera

A revolutionary new Polaroid camera and film system that produces colour pictures that develop in the light has recently been introduced in Australia. Employing advanced electronic control and sensing circuitry, the new camera features completely automatic operation.

Designated by Polaroid as the SX-70 Land, the new camera produces a developing picture, hard and dry, just 1.5 seconds after the user pushes the red electric shutter button. The pictures develop outside the camera, have good depth and brilliance, and no visible grain or structure. All that is required of the SX-70 user is that he compose the picture, focus, and push the shutter button.

Operation of the camera is entirely controlled by electronic microcircuits equivalent to some 400 transistors. These circuits control such functions as flashbulb selection, exposure control, mirror positioning, and ejection of the exposed print. The print is driven from the camera by a motor which is controlled so precisely that it is capable of accelerating to its normal operating speed of 12,000rpm in less than eight revolutions of the armature.

The advanced solid state controls of the Polaroid SX-70 have enabled Polaroid to produce a new, highly accurate, but extremely simple shutter actuated by specially designed solenoids. No cocking is involved. In ambient light, the double-bladed shutter is pre-programmed to select the best combination of aperture and speed. For flash exposures, lens aperture is automatically controlled by focussing. The automatic controls are able to cover a very broad range of lighting conditions, including time exposures for as long as 20 seconds.

The photocell which controls the electronic shutter represents a unique new development. The SX-70 utilises an ultra-sensitive silicon photocell which has a higher degree of precision than the nickel-cadmium cells found on most cameras. The logic circuits built into the camera deter-

mine the combination of aperture and shutter speed according to information received by the silicon photocell.


The lens used in the SX-70 required over a year of computer time to design, the result being an extremely compact lens containing four glass elements, each made from a different type of optical glass. Only the front element of the lens moves and the arrangement is so compact that the camera may be folded flat even when the lens is fully extended for close-ups. Despite its compact size, the lens focuses sharply from infinity down to 10 inches.

The double-bladed electronic shutter lies between the third and fourth element of the lens. Aperture ranges from f.8 to f.90, whilst shutter speed ranges from 100th of a second to 20 seconds. The focal length of the lens is 117mm.

Operation of the SX-70 is quite straightforward. The camera is opened by simply pulling the viewfinder housing upwards; a cartridge containing ten film cards is then inserted in the front of the camera, the protective cardboard film cover being automatically ejected during this procedure. The film pack also contains another completely new development: a 6V battery, so that the camera power source is automatically renewed each time a new film pack is inserted. The battery is used to power the motor, two solenoids and the control circuits. It is only $\frac{1}{8}$ inch thick, is slightly smaller than a playing card, and is capable of delivering up to 2.5A at peak load.

After an exposure, the film unit is automatically driven through two small steel rollers which rupture a small pod of reagent, spreading it between the film unit's positive and negative sheets to begin the development process. Simultaneously, a pivoting mirror assembly inside the camera drops down to cover the film pack and return the camera to the viewing mode for the next picture. The exposed film is then automatically ejected from the camera.

Within seconds of leaving the camera, the colour image begins to appear on the film. Migrating dyes from the negative push through from the reagent to form a colour picture on the inner surface of the transparent positive sheet. As the picture continues to develop, the opacifying dyes (originally deposited in the reagent to form a chemical curtain to shield the negative from further exposure) become completely colourless. The brilliant, saturated colour image is then seen against a highly reflective layer of white pigment.

Unlike previous Polaroid camera models, there is no requirement on the user to time the development process, no negative to peel away from the positive print, and nothing to be discarded. Once a photograph has been ejected from the camera, therefore, it may be completely ignored, enabling the photographer to shoot other photographs in rapid sequence if so desired. 



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The types illustrated are simply a basic cross section of the range available. The range embraces the widest possible variety of switch combinations to meet every requirement . . . Toggles, Rockers, Illuminated Rockers, Paddle Handle, Pushbutton.

Miniature, subminiature and microminiature sizes in many circuit/position configurations are available in one, two, three and four pole models. All switches feature rugged construction and simple mounting . . . long-term, trouble free operation is ensured.

Toggle switch contacts are rated 2 amps @ 240 VAC and 5 amps @ 28 VDC resistive load.

A catalogue containing full specifications, options, mounting information, panel layouts, etc., is available on request.

tear out and keep for easy future reference

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Subminiature
momentary
pushbutton



Standard
subminiature
toggle



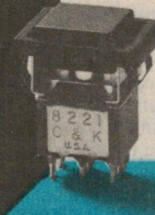
T Large toggle
large bushing
approx. ¾ size



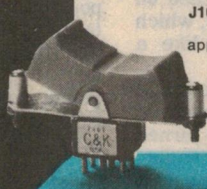
J60 Snap-in
Paddle/handle



Snap-in
illuminated
rocker
approx. ¾ size



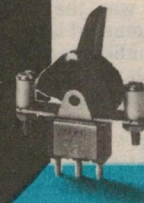
J Snap-in
pushbutton



J10 Rocker
approx. ¾ size



J4 Paddle
handle
approx. ¾ size



J2 Paddle
handle
approx. ¾ size



K Locking lever



Subminiature
momentary
pushbutton



Right angle
PC mounting
pushbutton



Right angle
mounting / Flatted
toggle



Right angle
mounting / Short
toggle



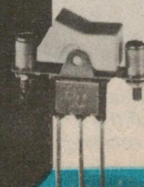
Right angle
mounting / Standard
toggle



Subminiature
single throw
pushbutton



Microminiature
single throw
pushbutton



J1 Rocker
Wire wrap
terminals
approx. ¾ size

Australia's radio pioneers — 4

The late 1920s to World War II proved to be the golden era of radio experimentation and home construction in Australia. In this, the final article of our four part series, the author looks at this era, and discusses the audio revolution that took place during this period and the introduction of stereo sound reproduction and experimental television.

by PHILIP GEEVES*

Most Australian families of the 1920s heard their first broadcasts on a crystal set. It was a modest investment and needed no batteries, yet it opened the door to a new wonderland. More affluent, or trendy, people often began with a valve set, perhaps even a multivalve receiver capable of driving a loudspeaker. These sets, with tuned RF stages on breadboard layouts mounted in coffin-like cabinets, enabled their owners to demonstrate the occult art of "tuning" for the benefit of wide-eyed friends. A large outdoor antenna was the distinctive hallmark of a radio home, at least until the first prosecutions of unlicensed listeners, when "there was a rush, not towards the licence counter of the GPO, but to get the backyard aerial down before the postman appeared the next morning."

One of the chief disabilities of early broadcasting was its poor reproduction of recorded music. Because small synchronous or induction motors and electro-

magnetic pickups had not been perfected, a spring-driven gramophone did duty as a studio record player: The vibrations of the heavy tone-arm were magnified by the gramophone horn and picked up by a carbon microphone. Discs were still made by the original acoustic process, their restricted dynamic range suggesting that all vocalists were singing at the end of a tunnel. The complex tonal patterns of keyboard instruments defied faithful reproduction from acoustic recordings. Consequently many broadcasters relied on the pianola as a musical reproducer, which anyone with two feet could play like a virtuoso.

The invention of electrical recording changed all that. The vastly improved frequency response of the new discs turned the gramophone into something of a vogue, prompting a noted Australian composer to comment on "the disconcerting popularity of music." The new process coincided with the introduction of dynamic cone speakers, so it was only a short step to electronic reproduction, with the output of a magnetic

pickup feeding into an audio amplifier.

The first pickups used in Australia were heavy devices, with magnets and armatures in full view. To avoid distortion, announcers changed needles after each record. Although this was an exciting period, it meant endless frustrations for professional radio men. Improvements in valve performance and amplifier design caused broadcasters to invest substantial capital in new audio equipment, but listeners with outmoded receivers could not enjoy the enhanced sound, or even notice it.

The new breed of "wireless addicts" preferred to build their own receivers. Radio magazines were largely responsible for the home construction craze, which gained momentum during the 1920s. They printed illustrated articles showing how to build receivers of every genre, explained circuit diagrams and even ran courses in simplified electrical theory. When technical editors published constructional details of popular models, radio dealers offered kits to home hobbyists. Regular radio exhibitions and amateur displays allowed laymen to study receiver layout and wiring techniques at close quarters. Most sets were battery operated until 1928, but increasing availability of domestic electricity produced the battery eliminator, which freed experimenters from the replacement of expensive B batteries and culminated in the triumph of the 'Twenties: the all-electric receiver.

The development of radio owed much to engineers who never lost the lively enthusiasms of their amateur days and, in fact, a number of professionals devoted their spare time to ham radio, thus enjoying the best of both worlds. Ray Allsop, who in 1925 became chief engineer of 2BL, was one of them. He relished the challenge of DX communication and allowed the general public to hear the results. In February 1925 Allsop's experimental station, 2YG, was heard in Europe on 80 metres. That same month he intercepted a shortwave test transmission from KDKA, Pittsburgh, the world's first broadcasting station, and relayed the program over 2BL.

In 1927 Allsop organised a similar rebroadcast of PCJJ, Hilversum, and the public response to this novelty gave him an even more ambitious idea. The BBC had not yet begun its overseas service so Ray Allsop arranged, through the Netherlands Consul in Sydney, for 2LO, London, to be relayed from Hilversum on 30 metres for rebroadcast over 2BL. This triple transmission proved enormously successful — the first time that Big Ben and the voices of London announcers were heard in Australian homes. It was not until May 1928 that the BBC was heard here somewhat more directly, when the Marconi Company



Spark transmitters saw a great deal of service in Australian merchant ships. Pictured above is the radio cabin of the SS "Burwah," equipped with an AWA ½kW quenched spark transmitter and panel receiver.

relayed to 2LO through its own shortwave outlet, 5SW, at Chelmsford.

Red-blooded Australians felt an intense involvement with Kingsford Smith's epic trans-Pacific flight from Oakland to Brisbane in 1928 and, because the "Southern Cross" carried radio equipment, it became possible to follow the aircraft's progress. Sydney Newman transmitted continuous Morse homing signals from AWA's radio centre, Pennant Hills, while Ray Allsop and Tom McNeil shared a long listening vigil, interpreting the cryptic messages from the "Southern Cross" and keeping 2BL's audience aware of every development. An American, Jim Warner, was the plane's radio operator and his gear was built by Heintz and Kaufman of San Francisco. The original transmitter may be seen in the National Library, Canberra.

Looking back, it seems that 1929 was a watershed year for Australian electronics. Overseas, the development of efficient audio amplifiers and loudspeaker systems had hastened the introduction of sound films — "talkies." In Australia, Ray Allsop took up the challenge. As early as 1921 he had succeeded in synchronising a wax cylinder recording with motion picture film; now he perfected his own Raycophone system which, despite bitter opposition from American interests, supplied the sound in almost half Australia's cinemas at a fraction of the cost of imported equipment. 1929 was also the year that AWA introduced its first domestic radiogram, the "Duoforte." Coinciding with the debut of sound films, the radiogram enjoyed widespread popularity as an exciting home entertainment package.

Many improvements in components and circuitry date from that time. One veteran remembers it as a stimulating epoch . . . "every week the radio papers printed a new circuit, so we would rush home to build it. Screen grid valves and power pentodes gave radio new horizons and, of course, the superheterodyne was a winner." Housed in splendid, handcrafted cabinets, console receivers of the 1930s were often the most impressive pieces of furniture in average homes and became the focal point of the family circle.

Public fascination with sound films soon generated a belief that television would not be long in coming and, it must be admitted, a few local visionaries were not averse to



Marconi's research chief, H. M. Dowsett (centre), operating an early TV receiver at La Perouse during his 1934 visit to Sydney.

suggesting that television was just around the corner.

An experimental TV station, using Baird's techniques, was built in Brisbane by T. M. Elliott and limited work was done by other experimenters. Three commercial radio stations, 3UZ, 3DB and 2UE, toyed briefly with the novelty of transmitting still pictures, but their enthusiasm outstripped the state of the art and public demand. A Melbourne firm, Television & Radio Laboratories Pty Ltd fostered the idea of Radiovision, which reproduced simple geometric figures on a special receiver. Experimental transmissions over Melbourne stations were soon abandoned. 2UE's interest centred on the Fultograph system, canvassed ardently by its British representative who, however, was realistic enough to concede that "transmissions will be of no value until the Fultograph receivers are distributed." And all this in a time of worldwide depression!

Some unusual hookups were adopted to carry film soundtracks to remote places, but few captured the public imagination so completely as the 1930 transmission from VK2ME which enabled Admiral Byrd's

expedition in Antarctica to hear Chevalier's film "The Love Parade" direct from the projection box of Sydney's Prince Edward Theatre. Spectacular achievements of this kind served to remind "John Citizen" that the unfolding science of radio was capable of infinitely more than simply producing agreeable sounds in his living room "wireless." And although Marconi never found time to visit Australia, the very association of his name touched any occasion with magic. It is impossible to convey the feeling of wonderment which engulfed Sydney in March 1930 when, from his yacht "Elettra" in Genoa harbour, Marconi switched on 2,800 lights in the Town Hall to inaugurate that year's radio exhibition.

Dual wave receivers of the 1930s gave Australians a window on the world at a time when European dictators were exploiting the power of radio propaganda. Short wave broadcasts became a commonplace and, through the crackle of atmospherics, that generation listened to history in the making. In Australia, too, short wave techniques were given some imaginative tests, such as the great Southern Seas broadcast on

Pictured below is an Australian-made twin turntable record player from the late 1920s. Below, right shows AWA engineer Harry de Dassel performing frequency measurements in the laboratory.





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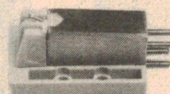
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- 4" 15 Ohm
- 5" 15 Ohm
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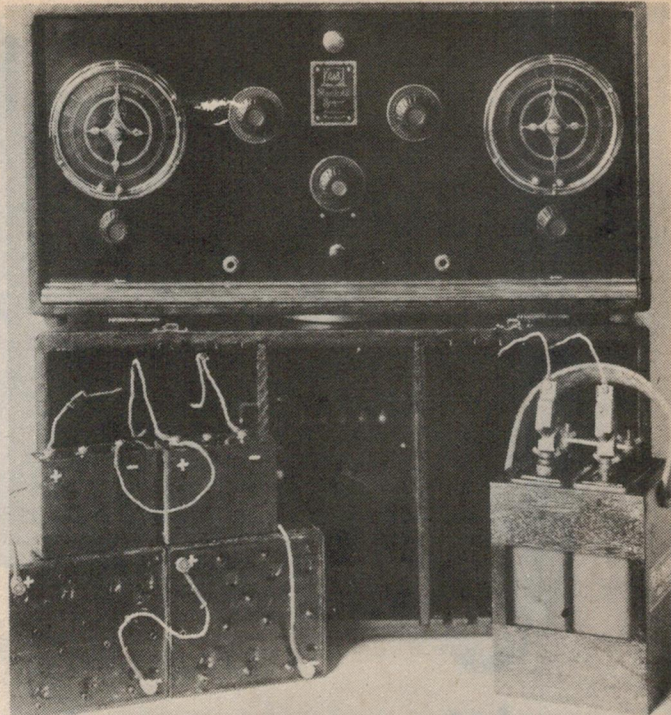
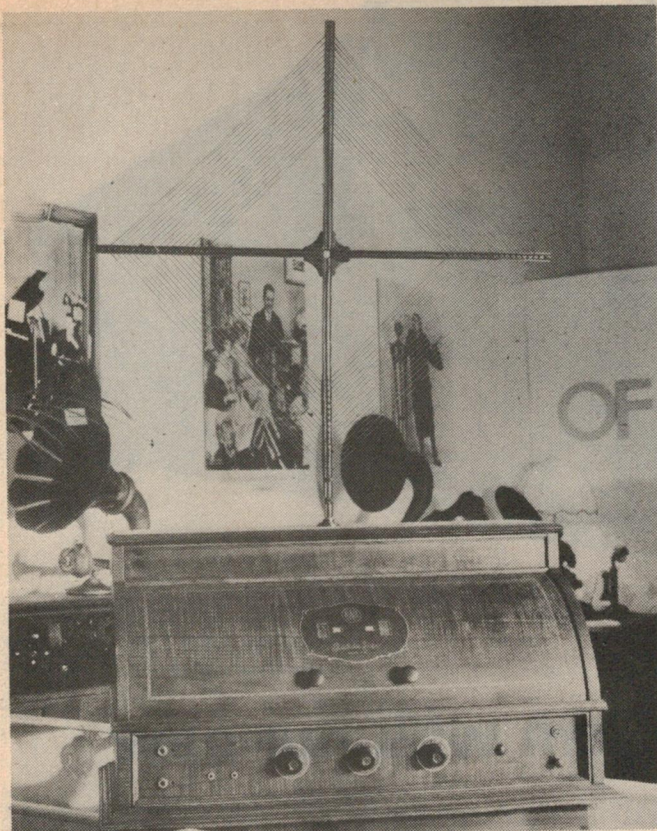
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Because it needed no outdoor aerial, the AWA Radiola Super (above, left) enjoyed phenomenal popularity following early prosecutions of unlicensed listeners. Above is a 1927 vintage AWA battery Radiola.

Empire Day 1933, the first major hookup in this part of the world. One report mentioned . . . "Nauru transmitted a word picture of natives listening with expressions of awe to the strange voices that came from the air. In New Guinea, miners on the goldfields were sitting around expensive receivers, bought with their newly-acquired wealth, listening to the flashing Empire messages. The minds of many went back to 1914 when intercommunication in the south seas depended on a few strands of cable."

The Wireless Institute of Australia was the sole active national body of its kind until 1932. Each State had a separate Division and the members' prime interest was amateur radio. However, industry leaders, immersed in the rapidly developing science of electronics, felt the need of a more

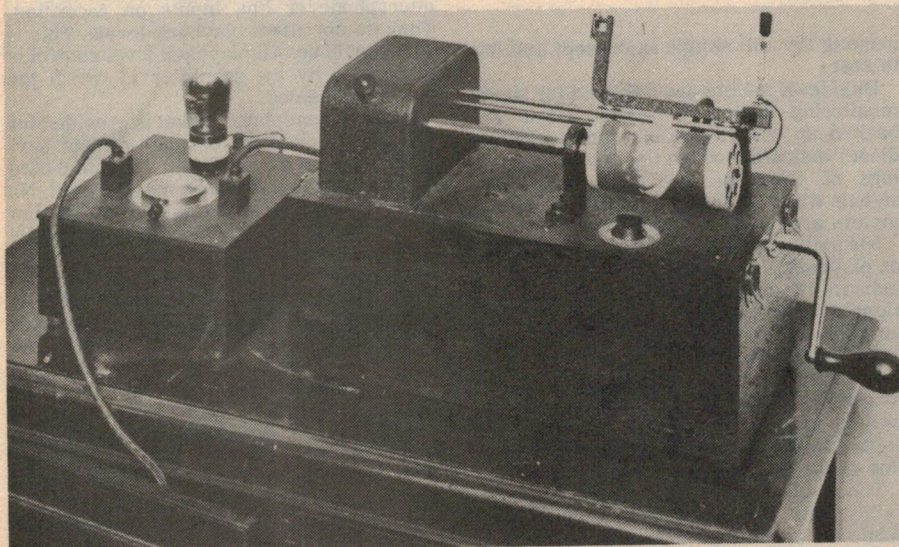
professional organisation. As a result, the Institute's membership began crystallising at two different levels. As early as 1924 Fisk, Mingay and other professionals had the foresight to register the Institution of Radio Engineers, Australia, but the planned organisation remained dormant for eight years when, by common consent, the IRE hived off from the NSW Division of the Wireless Institute.

The new body quickly established an enviable reputation by snaring some of the front runners of electronics as lecturers. In May 1934 Marconi's research manager, H. M. Dowsett, delivered a paper on "Television and its possibilities in Australia" and four years later the IRE had attained the requisite stature to host the first world radio convention ever held in the British Empire.

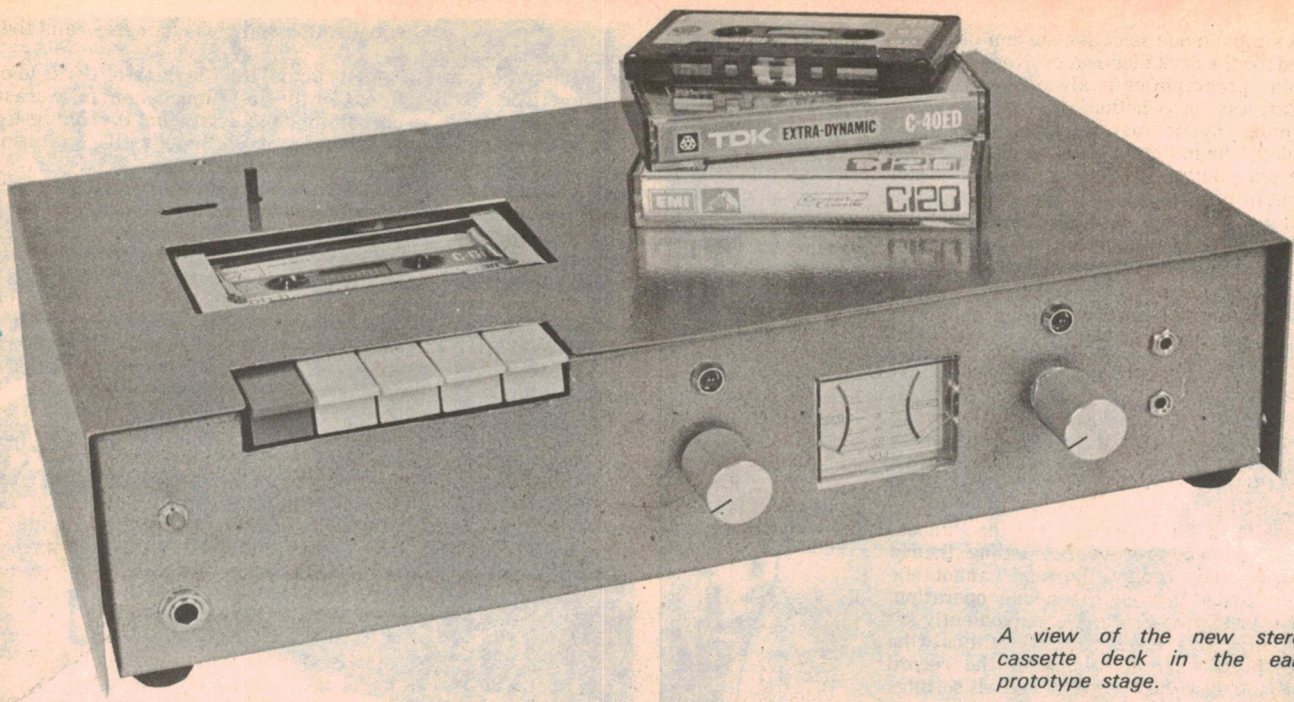
That prestigious conclave, which was part of Australia's 150th anniversary celebrations, attracted to Sydney many international figures, including General James Harbord, Chairman of RCA, and TV inventor John Logie Baird. More than sixty papers were read, a goodly proportion being contributed by Australian engineers.

One of the most memorable occasions of that 1938 convention was Ray Allsop's stereo demonstration — the first in Australia and only the second in the world. An audience of 2,000 in Sydney's Plaza Theatre listened to an orchestra playing in the nearby Regent Theatre, the stereo components being carried by two equalised PMG landlines to a sophisticated array of loudspeakers backstage at the Plaza (even in those days the terms "woofer" and "tweeter" were in use). In addition, Allsop treated his captive audience to some specially produced short films with stereo soundtracks, including a table tennis match which "was particularly realistic in that the bounce of the ball from side to side was easily followed, both visually and aurally." It is interesting to recall that this historic demonstration was described as "stereoscopic" sound, because it was thought that the word "stereophonic" had been copyrighted by overseas interests.

The 1938 World Radio Convention provided international recognition that Australian electronics had come of age and, as the stern lessons of history were to show, not a moment too soon. Within a few years Australia would be virtually isolated by the tides of conquest and would become the main strategic base and arsenal of the Allied war effort in the South West Pacific. When that occurred, the professional capability of the electronics industry would be taxed to the limit in producing the tools of victory on a scale that would have seemed impossible only a few years before.



Fultograph equipment of the type used for experimental picture transmission in 1921.



A view of the new stereo cassette deck in the early prototype stage.

Complete your sound system with our new

Playmaster stereo Cassette Deck

At long last, we have produced a complete circuit for a stereo cassette deck, to follow the replay preamplifier featured in the November 1973 issue. This first article describes features of the unit and some of the circuitry.

by LEO SIMPSON

After the publication of the cassette playback preamplifier circuit back in November 1973, many of our readers have apparently purchased Vortex cassette transport mechanisms in anticipation of a full cassette deck circuit becoming available. Several of our own staff have done the same but the circuit has been slow in development, for a number of reasons. However it has finally come to fruition.

Basically, the design is for a stereo deck using the Vortex cassette mechanism and with all the recording and replay circuitry necessary to enable it to be connected to a stereo amplifier via the line inputs. It has quite a number of what we feel are interesting features, particularly as some are not available on commercial machines.

To introduce the unit, let us discuss some of the features we have provided and justify why we have omitted other features which may seem equally desirable. We have tried to provide a good all round performance and plenty of operating facilities while

keeping the unit simple in concept and low in cost.

Dual level meters are provided for signal monitoring during recording. These are backed up with two LED (light emitting diode) indicators which flash instant warnings of transient overload. Thus peak signals which cannot be "followed" by the meters are detected and indicated.

Normally, the level meters do not operate on playback. However they can be made to indicate the relative level of the playback signal if the deck output is connected to the amplifier Auxiliary inputs rather than the Tape Monitor inputs, with the deck input still connected to the Tape output of the amplifier. In this way, the recording amplifiers may be fed with the playback signal. No instability problems result from this mode of operation.

The level controls are of the rotary type rather than the now popular sliding type. While we agree that they are appropriate for this application as they give ready

visual indication of their setting, the need to provide slots and special mounting brackets means that they are considerably more expensive than the conventional potentiometers.

Independent recording level controls are provided. These affect only the signals from microphone or line inputs on recording. They do not affect playback levels. This is as it should be. All playback level control is performed by the amplifier to which the unit is connected.

A stereo headphone socket is provided for listening to playback of tapes without having to connect an amplifier. Normal 8-ohm or high impedance phones may be used. No level control is provided for this output but the level can be easily varied if need be by selecting one resistor in each channel.

3.5mm jack sockets are provided for two low impedance microphones (250 to 600 ohms). These are shorting jacks so that noise from the recording preamplifier is minimised when the microphones are not in use. A five-pin DIN socket provides line inputs and outputs at a level of about 100mV, to suit typical stereo amplifiers. Other sources, such as AM tuner, tape recorder or ceramic cartridge in a record player may also be used for recording. The input impedance for the line inputs is 330k so bass response will be limited when used with ceramic cartridges.

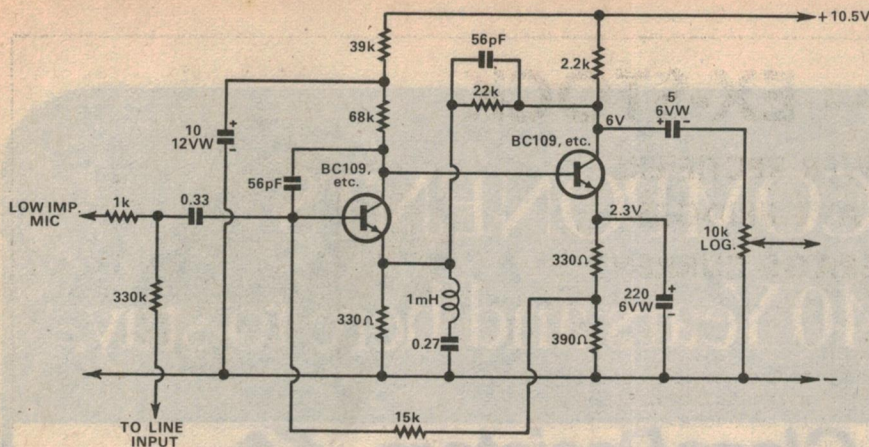


Fig 1, above, is the recording equalisation preamplifier circuit.

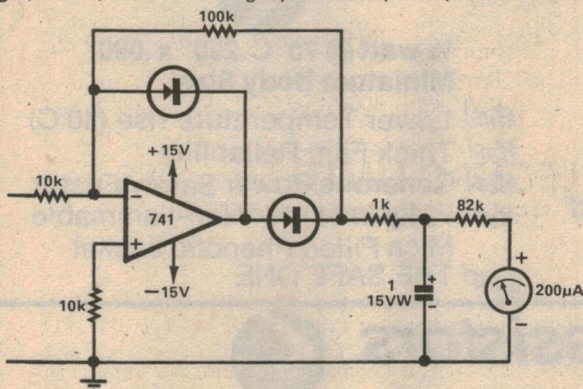


Fig 3, at left is the circuit of the metering amplifier of which two are used.

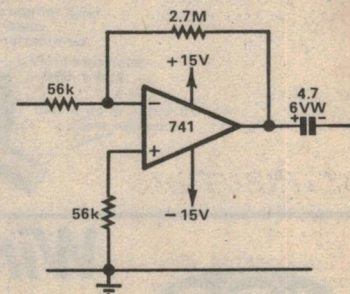


Fig 2, above is the recording amplifier.

possible to strong RF signals, there are two 56pF capacitors, one connected between base and collector of the first transistor and the other shunting the 22k feedback resistor. These ensure that response to RF signals is severely curtailed. In addition, there is a 1k "stopper" resistor in series with the microphone input.

Special measures have been taken to ensure that hum is not a problem. The supply to the collector of the first transistor is very heavily filtered by the 39k resistor and 10uF capacitor. The bias current for the input transistor is also heavily filtered from the emitter of the second transistor. The 220uF capacitor at the emitter also sets the low frequency roll-off of the circuit.

The output of the preamplifier is fed to the 10k level control and thence to the recording amplifier. This is shown in Fig. 2. It is a very simple circuit using the ubiquitous 741 operational amplifier.

Besides the fact that it only uses three resistors and one capacitor, the 741 op amp circuit has several advantages over a discrete circuit using two or three transistors. First, it is run from balanced plus and minus 15V supplies which gives it a massive signal handling capability, far more than it really needs. Another advantage is that it has a low output impedance which means that it can drive several circuits without any interaction between them. Finally it is biased from the OV line which means that hum is minimised.

Output from the recording amplifier in Fig 2 is fed to several parts of the circuit: to the recording head via a 22k resistor, to the metering amplifier, and to the overload indicator drive circuit.

Two separate metering amplifiers are employed to drive the meter movements, one for each channel. The metering amplifiers have a stringent task to perform.

Not only must they have a flat frequency response but they must give an accurate indication when reading signals of 100mV rms and less, if the meter calibrations are to mean anything.

Again, we have used 741 op amps as in the circuit in Fig 3. Here the 741 op amp is used as a precision half-wave rectifier with gain. Essentially, the high, open loop gain of the op amp is used to overcome the inherent voltage losses in the diodes. The precision rectifier works as follows: Negative half-cycles applied to the phase-inverting input

are amplified and inverted and fed through the series diode at the output. The 100k feedback resistor "looking at" the output via this diode sets the gain at 10 approximately (as a ratio with the 10k input resistor).

Positive-going half-cycles applied to the phase-inverting input undergo a different process. They are inverted by the amplifier and tend to be amplified by the full open-loop gain. However the diode connected directly between output and phase-inverting input is forced to conduct very heavily, which chops the gain back to almost zero. Thus for negative input half-cycles the op amp amplifies normally with a gain of 10 while for positive input cycles the gain is zero and no output occurs.

Thus the op amp precision rectifier acts like a diode, albeit with very little distortion of the half-cycle and with very low forward voltage losses. It can accurately rectify signals down to below 20mV RMS.

Two overload indicators, one for each

channel, are used. The circuit is shown in Fig 4. It consists of a silicon NPN general-purpose transistor operating as a class-B detector and driving a light emitting diode. A LED is used instead of a cheaper incandescent lamp, to obtain a fast response to short-term overloads. The potentiometer is set so that the LED just begins to glimmer when the level meter is reading 0dB. The LED achieves full brilliance for recording signals of more than plus 2dB.

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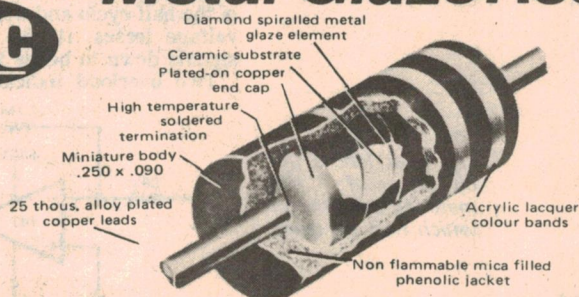
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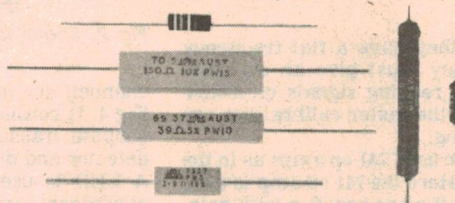


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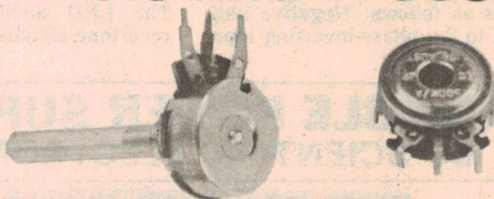
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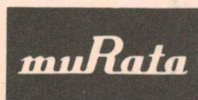
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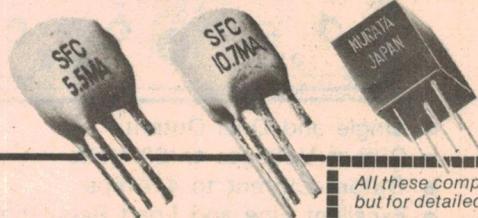
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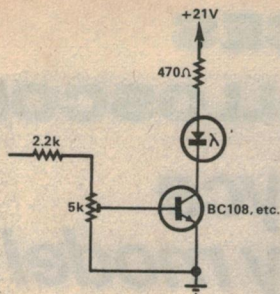


Fig 4, above is the overload indicator.

EMI describe it as a Colpitts oscillator tuned with the inductance of the erase head.

Because the erase head is in a series tuned circuit, the voltage applied to the head is considerably more than is available at the junction of the two 33 ohm resistors. Thus the erase head voltage is approximately 17V RMS (48V peak to peak) obtained from a circuit with a supply voltage of only 21V DC. Erase frequency is approximately 70kHz.

Series 10k resistors and a 10k preset potentiometer supply bias to the recording head.

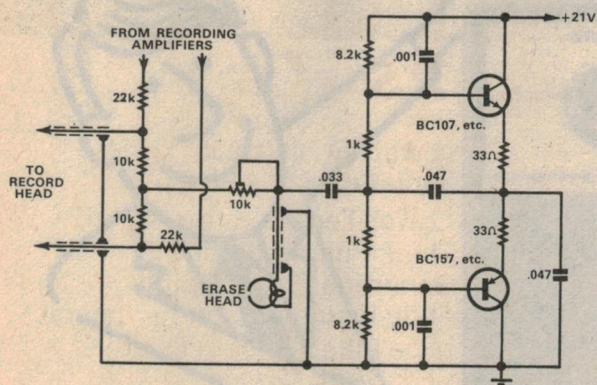
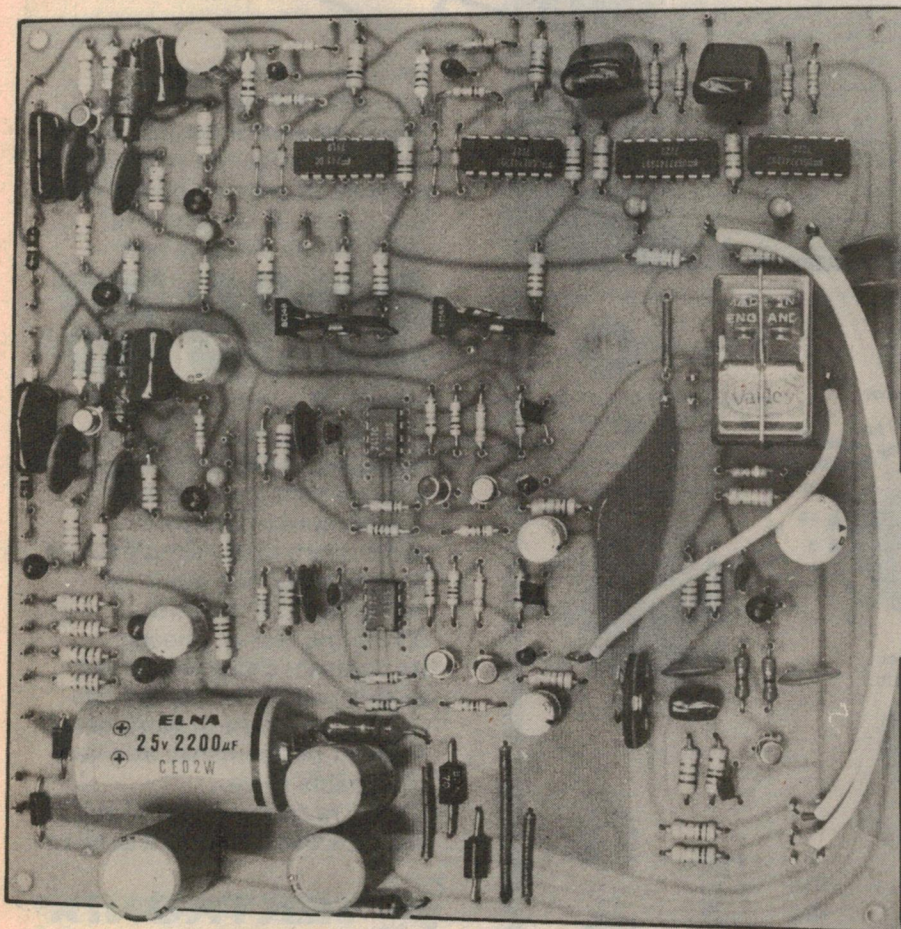


Fig 5 at left is the circuit of the erase oscillator which is tuned with the inductance of the erase head. Below is a general view of the circuit board which has been slightly modified in the final version.



The erase oscillator circuit is of special interest. It is the same as used in a cassette recorder manufactured by EMI (Australia) Ltd under the brand name "His Master's Voice". We used the circuit because of its economy of components and clever elimination of the oscillator transformer.

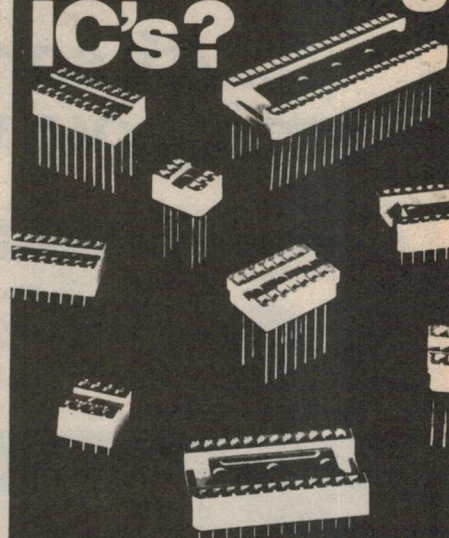
The replay preamplifier is the same as featured in the November, 1973, issue, but for one small change.

Next month we shall feature the complete circuit diagram and the constructional details of the cassette deck. First buy your cassette deck!

(To be continued)

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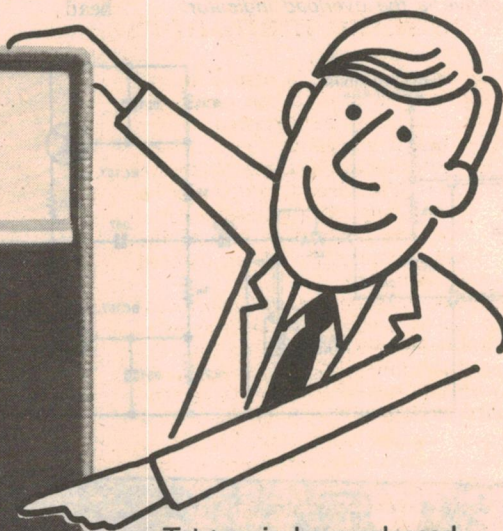
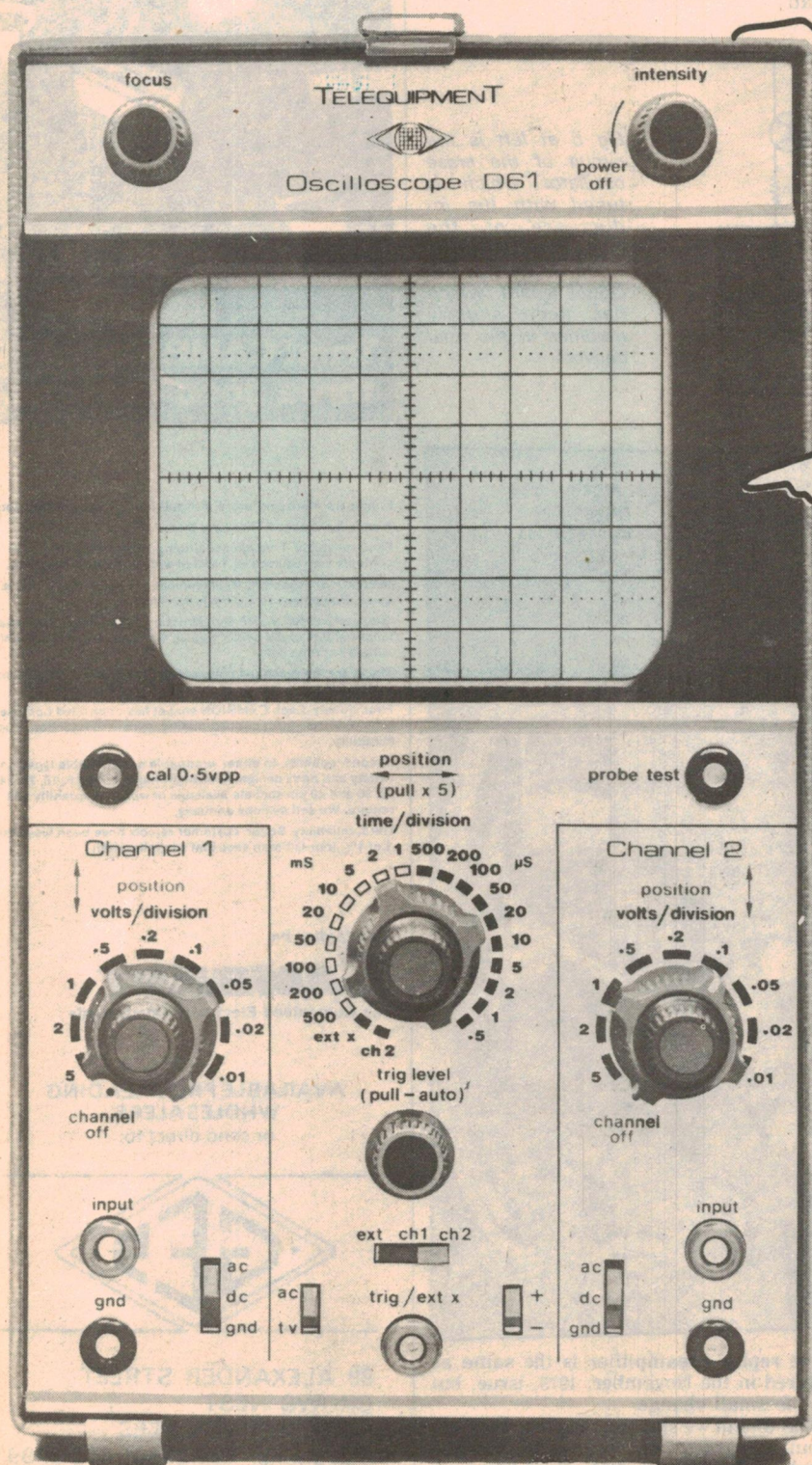
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Circuit & Design Ideas

Conducted by Ian Pogson

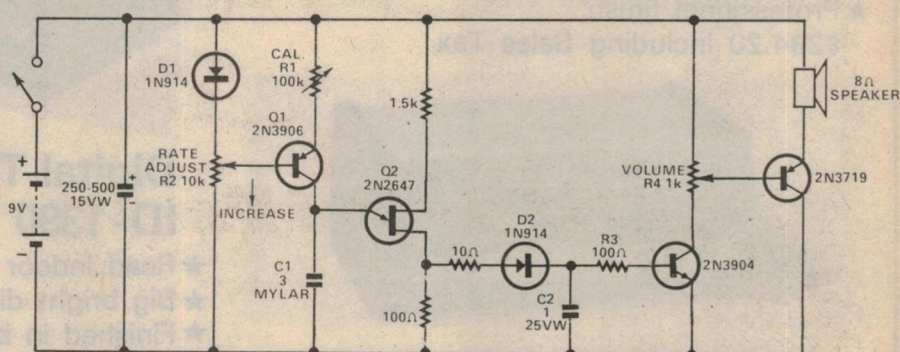
Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

All electronic metronome

For the engineer who is also a music enthusiast, here is a precision electronic metronome that can be adjusted to the desired beat rate, is accurate to within one beat per minute and can be assembled from standard parts. The circuit, which can be powered from any 9V transistor-radio battery, generates beats even beyond the standard metronome range—from about 15 to 380 times a minute.

A 10-turn potentiometer that has a turns-counting dial is used to set the beat rate. The circuit can be calibrated so that the setting of the potentiometer is accurate to well within one beat per minute over the standard metronome range of 40 to 208 beats per minute. Also, the circuit is relatively insensitive to variations in battery voltage.

A constant-current generator Q1 is used to charge C1. When the voltage across C1 reaches the firing point (above 6V) of the unijunction transistor Q2, the capacitor is discharged and an output pulse is generated. C1 charging current, and hence the operating frequency, is directly proportional to the voltage across the variable resistor R1, a voltage that varies



linearly with the setting of potentiometer R2. Diode D1 compensates for the base-emitter drop of transistor Q1.

The circuit is calibrated by adjusting R1 to obtain the upper standard beat-rate limit of 208 beats per minute and then adjusting the stop on the turns counting dial to get the lower standard limit of 40 beats per minute. Plenty of patience and a good stop-watch are needed for good calibration results.

The circuit employs a pulse stretcher, made up of diode D2, capacitor C2, and

resistor R3, to increase the available energy from the battery. The volume control may be replaced with a fixed resistor to obtain maximum output, if desired.

(By Dennis R. Morgan, in "Electronics".)

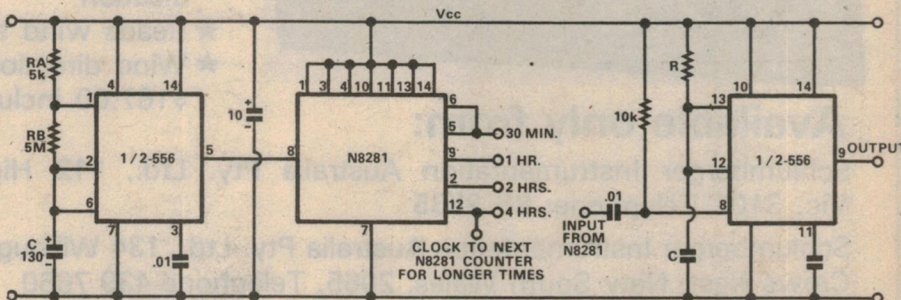
Editorial note: Instead of using an expensive 10-turn potentiometer and its dial, readers may be able to substitute an ordinary potentiometer, with a planetary dial and scale which may be devised to suit the individual purpose.

Signetics 556 dual timer

Each half of the 556 device behaves like a separate 555 timer and as such all of the applications indicated in the data sheet for the 555 are also applicable to the 556.

In the 556 timer the timing is a function of the charging rate of the external capacitor. For long time delays expensive capacitors with extremely low leakage are required. The practicality of the components involved limits the time between pulses to something in the neighbourhood of ten minutes.

To achieve longer time periods both halves may be connected in tandem with a "divide by" network in between, the first section operating in an oscillatory mode with a period of $1/f_o$. This signal is then applied to a "divide-by-N" network to give



an output with a period of N/f_o . This can then be used to trigger the second half of the 556. The total time delay is now a function of N and f_o .

(From "Technicalities".)

Editorial note: Two Signetics type 555 timers may be used in place of one type 556 to perform the same functions.

Frequency extender for electronic counters

Many amateur stations include 100kHz or 1MHz frequency counters. These counters are quite useful although limited in range. The upper frequency limit of such instruments can be multiplied ten times through the use of an IC prescaler. This device divides the applied frequency by ten and supplies an output suitable for application to the counter. Therefore, the prescaler produces a signal at 1MHz when the input is 10MHz. The unit shown in the

circuit can accept signals to about 11.5MHz at levels from 0.4 to 2V peak-to-peak and produces an output of 3.5V peak-to-peak.

If desired, the unit and its power supply can be built on a small piece of Vectorboard and mounted inside the counter. No special precautions need be observed in the construction other than the normal practice of keeping leads neat and short. For those not accustomed to working with integrated circuits, it is recommended that dual in-line

packages and sockets be used.

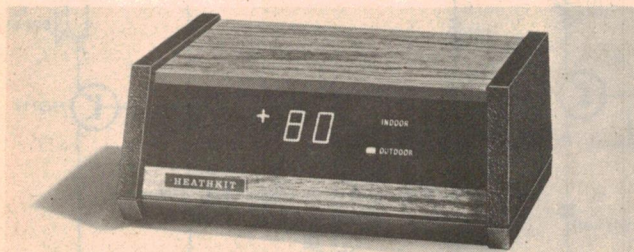
Appropriate substitutions can be made provided that the essential characteristics are maintained. Note that only one of the four gates of the SN7400N is needed. This IC was used because it was available. However, a dual-gate IC could be used instead. The unused input must be connected to +5.5V. When using a substitute IC be certain that the appropriate power supply voltage changes are made, if

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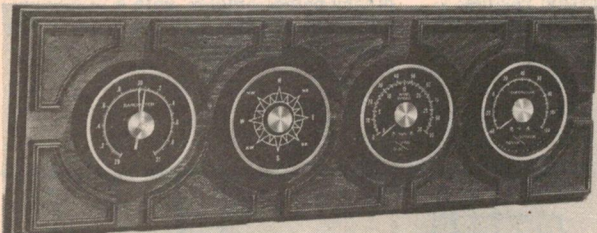
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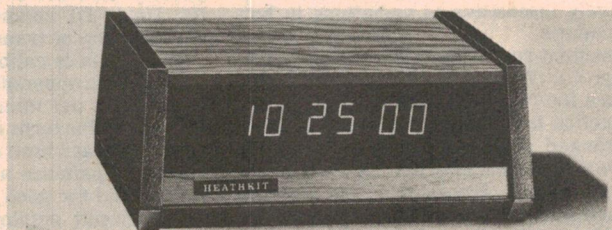
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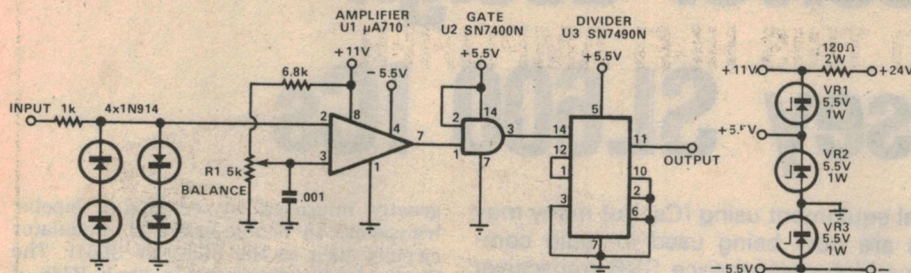
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CIRCUIT & DESIGN IDEAS



required, and that the substitutions are capable of operation at 10MHz.

The waveform to be measured is applied to the amplifier, a high-speed differential comparator. This amplifier produces pulses

which are applied to the 7400 gate. The output of the gate is in the form of 4-volt pulses to drive the 7490 decade divider.

Because both positive and negative voltages are required, a 24V supply is used

LM3900 IC as low-cost function generator

A versatile function generator that minimises hardware as well as cost can be built with one of the newly introduced National Semiconductor LM3900 Norton quad amplifier ICs. The price of the complete generator is just a few dollars and the entire unit can fit on a circuit board as small as 4cm square.

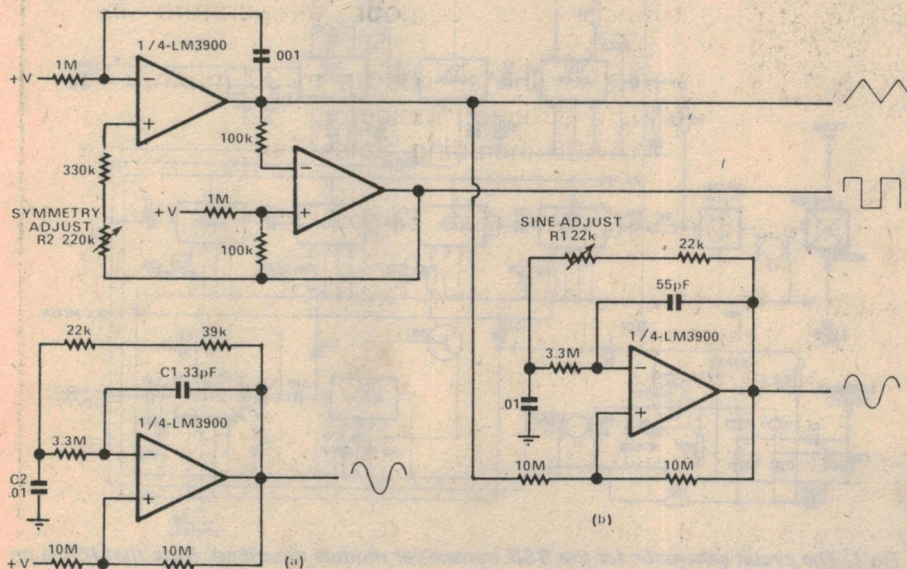
Only a single Norton amplifier is needed to obtain a sine wave generator as shown in (a). When resistor R1 and capacitor C1 are omitted from this circuit, the resulting configuration is the standard one for a Norton-amplifier square-wave generator, with the timing current passing through capacitor C2. The addition of an integrating capacitor C1 to this square-wave generator produces a reasonably accurate sine wave

at the output. Resistor R1, which helps to match the circuit's time constants, can be used to adjust the output sine wave for minimum distortion.

A similar circuit can be used to add a sine wave output to the conventional hookup for a square-wave / triangular-wave generator built with two Norton amplifiers. As shown in (b), the triangular output acts as the input for the sine-shaper amplifier.

For the component values given here, the circuit's operating frequency is around 700Hz. Resistor R1 is the adjustment for minimum sine wave distortion and resistor R2 is the adjustment for the symmetry of the square and triangular waves. The fourth amplifier in the Norton quad package can be connected as an output buffer.

(By P. Vlcek, in "Electronics".)



Non-polarised electrolytics

An improvement on the usual "Back-to-back" connection of electrolytic capacitors to form a non-polarised unit can be easily effected by using two diodes to short out automatically the "reversed" capacitor. The capacitors no longer have reverse

voltage across them as happens in the conventional arrangement, and also each provides its full capacitance (instead of only half of this) to the circuit. (From "Electronic Design.")

and the various operating voltages are derived from a zener diode voltage divider. Note that -5.5 , $+5.5$ and $+11V$ are all obtained from the same supply by placing the ground at the junction of diodes VR2 and VR3. All grounds shown in the prescaler must be connected to this junction.

The author's unit was fabricated on Vectorboard with a common ground tie point for the signal circuits. The 24V was provided from a regulated DC supply. However, a 24V transformer operating into a full-wave rectifier with a large filter capacitor on the output should be adequate since the load will not vary appreciably. The circuit draws about 60mA, most of which flows through the zener diodes.

(By Abram L. Winters, WA4FGN, in "QST".)

Editorial note: To avoid any possibility of exceeding the voltage ratings of the ICs, we suggest that 5.1V zeners be used for VR2 and VR3.

Note on burglar alarm

There is an error in my circuit for the Economical Burglar Alarm as presented on page 63 of May, 1974. The supply rail connected to the 40 ohm relay and the door or window contacts is labelled "-6V" and should read "+6V". Also, may I suggest that a 47k resistor be substituted for the 68k resistor as shown in the circuit, if a higher relay current is to be drawn.

(By Mr D. A. Scott, 32 Laburnum Street,
Blackburn, Victoria 3130.)

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SSB transceiver design using Plessey SL600 ICs

Most of our readers will have seen digital equipment using ICs, but many may not even be aware that these devices are now being used in radio communications gear. This article describes a high performance SSB transceiver module developed using the Plessey Semiconductors SL600 series of devices, and should illustrate the advances that have been made in this field.

by JAMES M. BRYANT *

The SL600 series of integrated circuits was developed by Plessey Semiconductors specifically for application in radio communications equipment. Since the devices were released, they have been used in many commercial and military communications equipment designs, including the "Clansman" UK/PRC 320 HF Manpack Transceiver designed and manufactured by Plessey Avionics and Communications. This transceiver operates over the frequency range from 2 to 30MHz, using USB, LSB, AM and CW (narrow band) modes.

The SL600 device range includes RF/IF amplifiers, a limiting RF amplifier-detector, AGC generators, an AF amplifier, VOGAD and sidetone amplifier, an AM detector, AGC amplifier and SSB demodulator, a multimode detector, a microphone/headphone amplifier, double balanced modulators and a square law device.

In a basic superhet receiver of conventional design the signal from the antenna, having passed through a preselector filter, is amplified and then mixed with a local oscillator to produce an intermediate frequency. This IF signal is filtered to remove signals on adjacent channels, amplified and applied to a detector. An AGC voltage is fed back to the RF and IF amplifiers.

This system has been in use, first with valves and distributed IF amplifiers — later with transistors and/or block crystal filters — since the late 1920s. In many respects it is ideal — it has high gain, low noise and excellent selectivity. Many of the most famous receivers of the past used such a system, but it has one severe drawback — the large gain in the relatively broadband stages prior to the IF filter can lead to large unwanted signals being applied to the mixer, which in turn (and especially with transistor mixers) leads to cross-modulation. Once cross-modulation has occurred no amount of subsequent filtering will cure it. The problem was less severe in the past for two reasons — the valve mixer is far less susceptible to such effects, and, far more important, in the past there were far fewer strong signals liable to cause such troubles than there are on today's crowded frequencies.

Modern receiver design has moved away from such techniques. The design of HF and

VHF receiver front ends is a difficult task, and the systems used in the highest performance receivers are often not only complex but closely guarded secrets as well. In principle, however, two criteria must be considered. Firstly, a minimum of gain between the antenna and the crystal filter — usually none at HF where antenna noise levels are high, but possibly 10dB at VHF and UHF so that mixer noise does not control system sensitivity. In mobile radios at VHF/UHF, however, sensitivity is often sacrificed for strong-signal performance. Secondly, the use of a mixer having as great a cross-modulation resistance as possible. Some common mixers are discussed below.

The bipolar transistor is a very poor mixer and suffers badly from cross-modulation. Its common use in television tuners is responsible for their extreme

greatly improved by employing bipolar transistors in double-balanced modulator circuits such as the SL640 or SL641. The SL640/1 will tolerate up to 30mV RMS of unwanted signal before cross-modulation of a 1uV signal reaches 1pc. This is not a very good performance by the standards of modern HF receivers; nevertheless the SL640/1 may be used in medium performance receivers where its low local oscillator power requirement and extreme ease of use in some degree compensate for its less than ideal large signal performance. It should be noted that if the SL640/1 be preceded by an SL610 to which no AGC is applied, the signal at the antenna needed to produce cross-modulation is reduced from 30mV to 3mV. This is not satisfactory.

A single balanced modulator using a matched pair of junction FETs can have useful gain, low noise, and high cross-modulation resistance, but has one disadvantage in that quite high local oscillator power is required. Nevertheless, it has been demonstrated that a mixer with 2.5dB gain, working from 50MHz to 300MHz and capable of handling signals in excess of 2V RMS can be made using this technique.

The dual-gate MOSFET is another useful mixer. The fact that it is more often used at

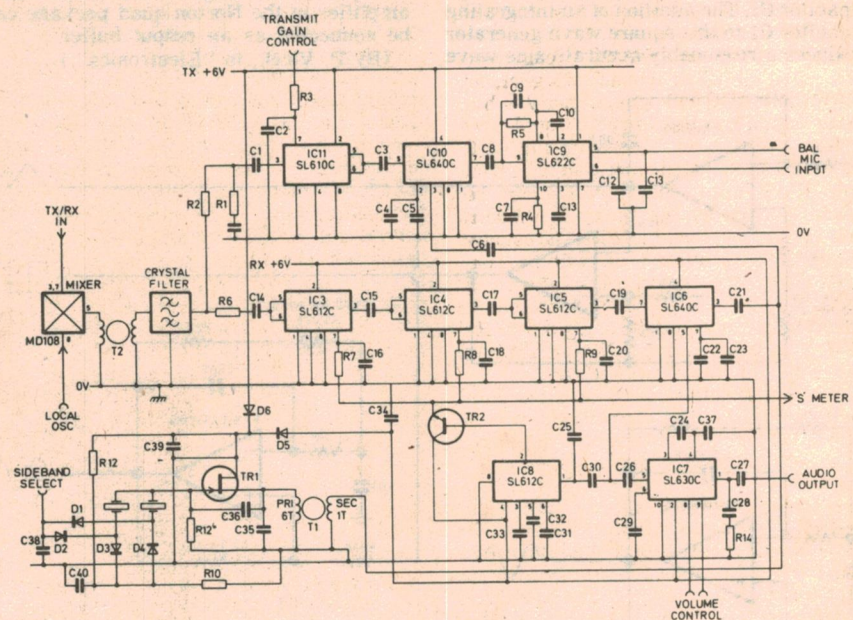


Fig 1: The circuit schematic for the SSB transceiver module described. Note that IC8 is an SL621C, not an SL612C as shown.

susceptibility to cross-modulation by local transmitters. However, the use of bipolar transistors in the microwave region can give some cost advantages over other systems. Junction FETs, although far better for the purpose than bipolar transistors, do not make ideal mixers when used alone.

Cross-modulation resistance can be

VHF than at HF appears to result more from custom than for any real technical reason. It will handle signals of over 150mV, but its biasing is somewhat critical. Local oscillator requirements, however, are modest and it can have both useful gain and low noise figure.

Of all the mixers in use today, however, the diode ring is undoubtedly the best. Using

*Linear Applications Manager, Plessey Semiconductors, Swindon, Wiltshire, U.K.

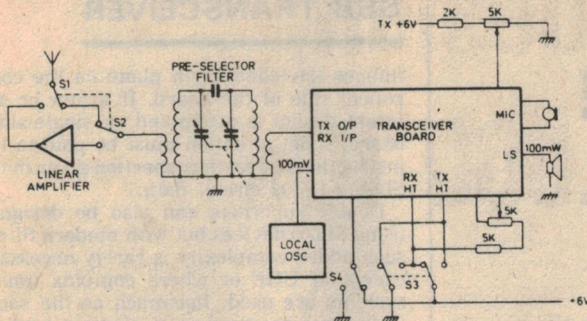


Fig 2: A block diagram showing how the transceiver module is intended to be used to form a complete transceiver. At right is the list of small parts.

four matched diodes of any type (most commonly used are silicon Schottky diodes and, in low-cost systems, germanium diodes), this mixer has many advantages. It is bi-directional (so that it may be permanently connected to the filter of any transceiver and yet be used on both transmit and receive) it will suppress very large unwanted signals — although this is also dependent on the local oscillator power inserted — and can be used at frequencies up to several GHz. Disadvantages of the diode ring mixer are its high local oscillator requirement, its conversion loss of about 6dB, and its noise figure of 5dB or more. Several manufacturers make silicon Schottky diode rings with very broadband 50ohm ports at quite reasonable prices. One of these diode ring mixers is used in the transceiver design described in this application note.

The mixer, therefore, and any RF amplification preceding it, must be as resistant as possible to cross-modulation. It may be noted that while an SL640/1 can only tolerate 30mV RMS of unwanted signal, an SL610 without AGC will accept 100mV — but a mixer capable of handling 1V would have to follow it. Using an SL610 with full AGC cross-modulation is encountered at about 250mV RMS input. The mixer must be followed at once by the filter. In modern sets a crystal or ceramic filter is usually employed, so no other type will be considered here. The bandwidth of the filter depends on the signal being received — bandwidths commonly used being 300-600Hz for CW, 2.7kHz for SSB, 5.5kHz for AM and between 10 and 25kHz for NBFM.

The filter is followed by a high gain broadband IF amplifier consisting of two or three SL612s followed in turn by a detector, AGC generator and the audio stages.

The receiver section of the SSB transceiver to be described shortly has been designed along the lines outlined above. It consists of a diode ring mixer fed from the antenna via a preselector followed by a crystal filter (an SEI QC1246 AX 2.4kHz bandwidth 9MHz filter was used in the prototype) and a 3-stage SL612C IF amplifier. An SL640C acts as product detector and feeds an SL621C AGC generator and an SL630 audio amplifier.

The AGC line is decoupled to keep RF from the AGC inputs of the SL612Cs but too large a value of decoupling capacitor degrades the impulse interference suppression characteristics of the SL621C. This type of suppression, while not as effective as a full noise-blanking circuit, nevertheless reduces impulse interference to an ac-

ceptably low level for most receivers. A suitable total capacitance on the AGC line is 0.015uF. The resistor in the AGC line of the first SL612C should be larger than the resistors in the AGC lines of the other two devices; alternatively a silicon diode could replace the resistor. Either of these techniques will ensure that the first SL612C remains at full gain for a while after the detector output has passed the AGC threshold, thus maintaining a high signal-to-noise ratio.

The supply line is decoupled at LF to prevent supply current surges (which in the SL621C can be induced by step signals) from interfering with other circuits. HF decoupling is unnecessary since the SL612Cs have sufficient internal decoupling, but it is advisable to earth the cans to pin 8. The interstage IF coupling capacitors should be kept as small as possible — at 9MHz 100pF is adequate — to ensure that LF signals at the output of one SL612C (due to noise or AGC action) do not reach the next stage and give rise to low

frequency instability as the receiver passes the AGC threshold.

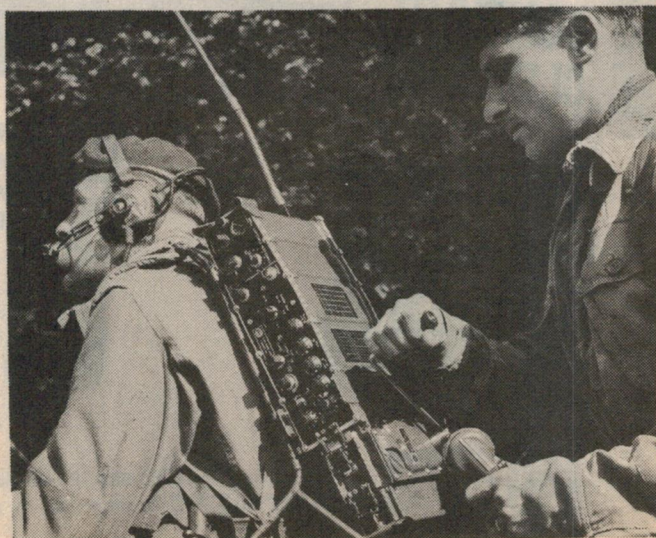
Earlier designs of SSB receivers using SL600 devices had a preset control to adjust the AGC threshold. This is now considered unnecessary, provided that AGC to the first gain stage is delayed (as described above) until the input reaches at least 3uV. The audio output from the receiver is a maximum of 100mW which, while entirely adequate for headphone and normal domestic or fixed amateur use, may be insufficient for mobile or professional applications (although a listening test is worthwhile here, as 100mW is louder than most people imagine). If more output is needed, however, an extra power amplifier may be mounted off the board.

The circuit board for the transceiver uses single-sided copper board. It should be noted that the layout is extremely critical and deviations from it are likely to lead to instability. If a different layout is used it would be better to use double-sided board and make all earth connections to a con-

MODULE PARTS LIST

Circuit Reference	Value	Rating	Type
R1, R3, R7-9, R11	100ohm	¼W	Hi-stab carbon film
R2	430ohm	¼W	Hi-stab carbon film
R4	30k	¼W	Hi-stab carbon film
R5	1k	¼W	Hi-stab carbon film
R6	50ohm	¼W	Hi-stab carbon film
R10, R13	330ohm	¼W	Hi-stab carbon film
R12	100k	¼W	Hi-stab carbon film
R14	10ohm	¼W	Hi-stab carbon film
C1, C2, C3, C4, C11, C12, C22, C29	1nF		Wee Con ceramic
C5, C8, C23, C26	10uF	6.3V	Plessey tantalum bead 402 / 1 / 54006 / 130
C6	100pF		Erie Hi-K submin, tubular
C7			
C32	47uF	6.3V	Plessey tantalum bead 402 / 1 / 54009 / 100
C9	47nF		Wee Con ceramic
C10	2uF	16V	Plessey tantalum bead 402 / 1 / 54006 / 090
C13, C25, C39, C40	0.1uF		Wee Con ceramic
C14, C15, C17, C19, C21, C37	100pF		Ceramic
C16, C18, C20, C24	4.7nF		Wee Con ceramic
C27, C31, C33	100uF	6.3V	Plessey tantalum, bead 402 / 1 / 54017 / 040.
C28, C38	10nF		Wee Con ceramic
C30	1uF	35V	Plessey tantalum bead 402 / 1 / 54006 / 070
C34	400uF	16V	Miniature aluminium electrolytic
C35, C36	68pF		Ceramic
D1-D6	1N4148	—	Semtron
TR1	2N3819		
TR2	2N706		

The Plessey B20 manpack SSB transceiver, the first to use the SL600 series of ICs for radio communications. Total weight is less than 20 pounds.



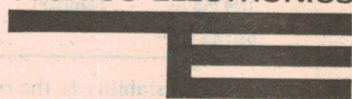
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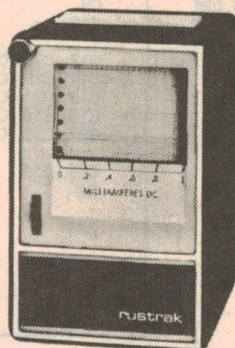
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SSB TRANSCEIVER

tinuous unetched earth plane on the component side of the board. If a new or different design is attempted on single-sided board, strict attention must be paid to the instructions on earth connection given in the SL610/11/12 circuit data.

Double superhets can also be designed using SL600 devices but with modern filters such added complexity is rarely necessary except at UHF or where complex tuning systems are used. Inasmuch as the same techniques are used as in single superhets such systems are not described here, but it should be noted that SL600 devices have high gains, therefore too many amplifying stages should be avoided.

Let us now consider the transmitter or exciter section of the design.

Two types of SSB generator are in common use; filter systems and phasing systems. A basic filter system may be built using only two SL640C balanced modulators. The audio and a low radio frequency from an oscillator (the BFO if the system is part of a transceiver) are mixed in one SL640C which, as a result of its good carrier rejection, gives as its output a clean DSB suppressed-carrier signal. This is passed through a narrow bandpass filter to remove one sideband, the remaining sideband is converted to the final frequency by another SL640C and the image is removed by a filter. The output is then applied to the transmitter linear amplifier possibly using a Plessey Semiconductor SL1030 as its first stage.

A more complete filter system would have an SL610C as an internal amplifier which is controlled by an automatic level control signal. This in most cases would be derived from the final linear amplifier — either by a threshold detection system or by grid current detection in the output valve.

A phasing system may also be built using two SL640Cs. The audio input, which must normally be of limited bandwidth, is phase shifted so that two audio lines of equal amplitude but separated in phase by 90 degrees are obtained. These audio signals are applied to the signal inputs of two SL640Cs. RF reference and quadrature signals are applied to the carrier inputs, and the two outputs are summed. If the audio reference and carrier reference signals are applied to one modulator and the audio and carrier quadrature signals to the second, the LSB outputs will be in phase and will add, and the USB outputs will be out of phase and will cancel. Thus, LSB is obtained. Similarly if audio reference and carrier quadrature are applied to one modulator and audio quadrature and carrier reference to the other, USB is obtained.

This method appears attractive in many respects and has the advantages that no expensive filters are used and that the carrier frequency may be varied, so that further conversion may not be necessary. The disadvantage is that to keep the second sideband the required 40dB below the desired sideband the phasing, both audio and RF, must be very accurate — in fact within 2 degrees. In addition, the amplitude of the carrier applied to one modulator must be critically adjusted to minimise second sideband generation, and carrier leak must be minimised on both modulators.

Despite the adjustment problems, this



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method of SSB generation is very popular — probably because of the saving of expensive filters.

In the transmitter exciter section of the transceiver design given here, the filter method is used. This makes use of the same BFO and crystal filter used in the receiver, simplifying the circuit and significantly reducing costs while keeping the adjustments to a minimum.

As transmitters often contain large RF fields, particular attention must be paid to screening and decoupling. In some cases it may be necessary to decouple individual stages. In areas of high field, device cans should be individually earthed.

The following brief description of a unit which forms the heart of a single sideband transceiver design using SL600 devices should illustrate in a practical way the points discussed in the foregoing. The transceiver could be adapted for use from 10kHz to 500MHz. The basic module as described is constructed on a single printed circuit board and requires only a local oscillator, linear amplifier, preselector, microphone and loudspeaker or headphones to complete the transceiver. The circuit is shown in Fig. 1.

RECEIVER

The receiver is a single conversion superheterodyne with a 9 MHz intermediate frequency. In order to improve the cross-modulation characteristics there is no RF amplification, high gain being provided by the IF stages.

The input mixer is an ANZAC MD108 hot carrier diode ring, which is used in order to obtain good large signal performance. The mixer input (pins 3 and 7) is obtained from a pre-selector, which prevents the image frequency being received. The local oscillator signal is applied to pin 8 of the MD108 at a level of about +7 dBm (500 mV). A toroidal transformer is used to match the 50ohm output of the mixer to the crystal filter. IF amplification is provided by three cascaded SL612Cs, which are followed by an SL640C used as a product detector. The carrier insertion oscillator is an FET which delivers 100 mV RMS into the product detector. The audio amplifier, an SL630C, provides 100 mW output into a 40ohm loudspeaker; audio gain control is by means of a DC potential applied to pin 8 of the SL630 by a 5k potentiometer in series with a 5k resistor, as shown in Fig. 1.

Automatic gain control is provided by an SL621C AGC generator, the transistor TR2 being used to buffer the output of the SL621C so that an 'S' meter may be driven from the emitter of TR2 if required. C16, C18 and C20 are kept low (4700pF) in order to retain the ignition suppression characteristics of the SL621C system.

TRANSMITTER

The transmitter is also single conversion. It generates SSB at 9 MHz by the filter method using the same crystal filter as the receiver. An SL622C is used as the microphone pre-amplifier; this device has its own AGC which automatically adjusts the output to suit the SL640 balanced modulator.

The SL640C is followed by an SL610C amplifier which has ALC (derived from later stages of the transmitter) or a DC RF gain control applied to pin 7 of the SL610C. Resistors R1 and R2 provide the correct match to the filter.

The diode ring mixes the 9 MHz SSB with the local oscillator to produce the required output frequency (and of course the image

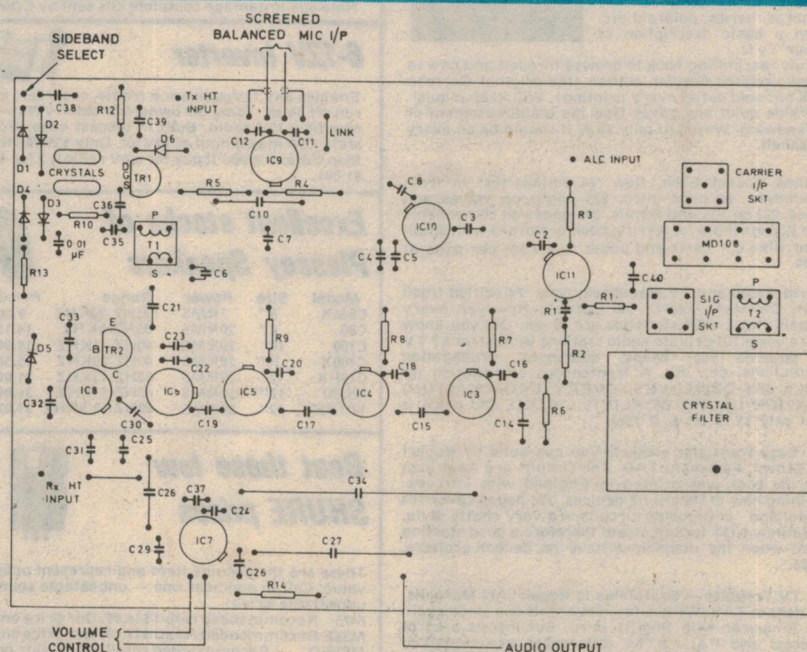
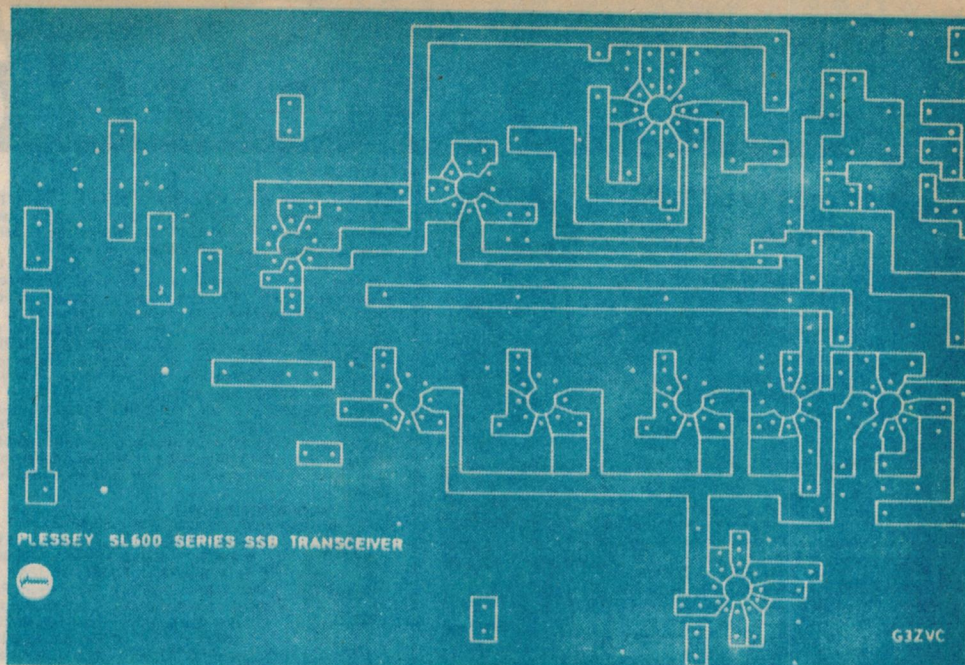


Fig 3 (top): The board pattern for the transceiver, shown actual size (12.9 x 8.5cm). Beneath this is Fig 4, showing the disposition of components and wiring on the top of the board. Board layout is critical.

frequency which afterwards must be removed).

The carrier injection is provided by an FET oscillator, with 2 diode-switched crystals for upper and lower sidebands.

CONSTRUCTION

The circuit board is single-sided, with two wire links on the top — one in the receive HT line the other the transmit HT line. The layout of this transceiver is critical; change of printed circuit design is not recommended as this could lead to instability.

Transformer T1 is made from four 2-inch lengths of 26 SWG wire twisted together, the twisted wire is then used to wind two turns on a CR 071-8A core (ITT). Any linear ferrite or iron dust toroid with an inside diameter from 1/2 to 1 1/2 cm should be satisfactory. The ends are then separated and three windings connected in series for form the secondary, the primary being the remaining winding.

The board may be used as a receiver by

omitting the following components: R1 to R5 inclusive, C1 to C13 inclusive and the three integrated circuits used in the transmitter. A 500 ohm resistor should be connected between the crystal filter output and earth.

The 100 mW audio output has been found adequate for most purposes but if extra power is required it could be obtained from a Plessey SL414 audio amplifier external to the board. In practice the sensitivity of the receiver is satisfactory up to 30 MHz but above this frequency an RF amplifier is useful to take advantage of the lower atmospheric noise.

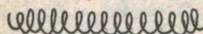
ACKNOWLEDGEMENT

This article has been adapted from applications literature on the SL600 series of communications IC devices, published by Plessey Semiconductors, by arrangement with Plessey Australia Pty Ltd, Components Division, Professional Products Department.

Dick Smith Ele

Bookworms Corner

Chew your way through some of these (most are in paperback form so are excellent value).



P & P 50 cents unless stated.

HOW THINGS WORK (subtitled 'The Universal Encyclopedia of Machines') is a veritable goldmine of information. Packed into 600 pages are the answers to questions that confuse the layman. Over 1000 two colour diagrams tell you why zippers zip, how soap works, what nylon is, why a ship floats and on to synchromesh and automatic transmissions... rockets and explosives... cameras, lenses, polaroid etc. Even a basic description of colour TV!!

A truly fascinating book to browse through and now in a new updated English edition (the original German book has sold out at every printing). Will keep inquisitive kids quiet and saves Dad the embarrassment of not knowing 'Why?' At only \$3.90 it should be on every bookshelf.

Philips Pocket Book. New '74 edition just in from Eindhoven. 60 page intro, 235 pages on valves and tubes, 233 on ICs and semi's, 293 pages on components and 32 page index. A terrific book crammed with small print (like our cat!) and under 1/2 a cent per page at \$2.30.

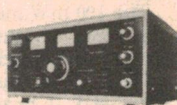
World Radio and TV Handbook. New '74 edition fresh from Denmark (sorry no porno). However every transmitter's vital statistics are given. Did you know there were 104 private radio stations in Australia? TV is covered too. Maps, addresses, propagation predictions, etc. A tremendous compilation for SWLs and DXers. YES, EVERY BROADCASTING STATION IN THE WORLD IS LISTED. Old price is still only \$5.75 (P & P 75c)

104 Easy transistor projects you can build by Robert M. Brown, Foulsham TAB. The circuits are American but the book was printed in England with intro explaining how to substitute devices. 224 pages cover 104 useful and/or amusing circuits in a very chatty style. Definitely NOT technical and therefore a good starting point when the magazines have no decent projects. \$4.05

101 TV Troubles — Symptoms to Repair. Art Margolis, Foulsham TAB. We hesitated over this one since again it's American with English intro. But there's a lot of interest and PAL NTSC differences are explained (not that there's many colour sets yet to go wrong). Chapters include: No brightness — no sound; AGC symptoms; Horizontal shrink. 220 pages very direct approach with circuits, photos, etc. \$4.75. Or set yourself up as a Serviceman with our Telefix calculator which we will supply with the book for only \$6.99.

Trio 9R-59DS Communications Receiver

An ideal set for Amateurs and Short Wave Listeners. 4 bands covered from 540kHz to 30MHz. Two mechanical filters to improve selectivity. Product detector for SSB. Large dials for accurate tuning. Automatic noise limiter. Calibrated Bandspeed. 'S' meter and BFO. 20V sensitivity for 10dB S/N. Built-in speaker and 1.5W output. \$152 (P & P freight on).



\$152.00

Ultrasonic Transducers

New models 40T, 40R are more sensitive than the ones featured in FEB E.A. Range to 150' with no licence required. Ideal burglar alarms. Only \$5.95 each (state transmit or receive). Kits for article with new type transducers. Transmitter only \$9.75. Receiver \$19.75 (both P & P 75c).



BUILT THE ETI 422 SUPERKIT 100Wrms AMPLIFIER

Congratulations to Electronics Today on a really great amplifier. We are proud to announce that this project is to receive the Superkit treatment with exclusive fibreglass boards. Just check the spec alongside.

The kit will be available in 3 stages to suit your budget. Compare the finished amplifier with commercial units at twice the price. We have secured the most magnificent TEAK cabinet to house the project which gives the final professional touch. Your friends just won't believe it's home made.

Kit 422A Pre-Amp consists of the 420B PCB and all components for the low noise Pre-Amp including fibreglass board \$24.50 (P & P \$1.00)

Kit 422B Main Amp and Power Supply consists of the ETI 422 Power Board fibreglass and all electronic components for it and the power supply including transformer. \$62.00 P & P \$1.50.

SPECIAL COMPLETE KIT FOR ONLY \$118.00 includes all sections ABC above and full instructions (P & P \$2.50). On a limited budget. Then get Kits A and B only and supply your own hardware. Special price only \$82.50 saves you \$4.00. Or fit it in your own cabinet by ordering full kit less cabinet for \$113.00. Missed the article? Then send us a stamped self addressed envelope (fullscap) and we will send full details.

Separate components available

ETI420B Pre-Amp Board (fibreglass) \$2.80 ETI422 Amp Board \$3.60 2500/50V electros \$1.80 each McMurdo 2900-4 switch \$3.60 9504/3577 Transformer \$11.75 (P & P 75c) McMurdo 2904/1 switch \$1.40 Front Panel \$3.50 Chassis \$6.90 (P & P 75c) McMurdo phone jack 75c WBF003/3 heatsink \$1.90 LED Indicator \$1.45 TEAK cabinet \$8.00 (P & P 75c) 4 input RCA strip 80c. Back panel \$4.50.



"BEAT THIS SUPERKIT VALUE" WITH OUR EXCLUSIVE FIBREGLASS BOARDS.

Note due to damage complete kits sent by COMET, No P.O. Box addresses please.



SPECIFICATIONS

Power output 50Wrms
Frequency Response 5dB from 20Hz to 20kHz
Channel separation 45dB
Hum & Noise - 78dB (aux) - 67dB (disc) Input sens. Aux 210mV Disc 2.1mV, Main amp 500mV Distortion (10W) 0.16% Tone controls ±13dB. Damping factor >70. PCBs in fibreglass throughout. Handsome teak cabinet. Full instructions.

ONLY \$118

6-12V Inverter



Enables any 12V appliance (radio, recorder, etc) to be run off 6V dc. Ideal for owners of older VWs — you can now fit a 12V radio. Built in diecast case. Fully solid state 1.5A max output at 12V dc. Only \$29.95 (that's less than the extra you'll pay for a 6V radio), 2 for \$50 (P & P \$1.00).

Excellent stocks of Plessey Speakers



Model	Size	Power	Range	Price	P & P
C8MX	8"	7RMS	35HZ-20KHZ	9.50	50c
C80	8"	20RMS	35HZ-8KHZ	14.10	1.00
C100	10"	20RMS	40HZ-11KHZ	14.00	1.00
C100X	10"	20RMS	40HZ-20KHZ	15.50	1.00
C12PX	12"	30RMS	35HZ-13KHZ	21.00	1.00
12U50	12"	50RMS	40HZ-11KHZ	36.00	1.00
12UX50	12"	50RMS	40HZ-13.5KHZ	39.00	1.00

Beat these low SHURE prices



These are the genuine item and represent outstanding value. Call in and hear one — unbeatable sound, at an unbeatable price!

M75 Recommended retail \$16.00. Our price only \$13.50
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M91ED Recommended retail \$38.00. Our price only \$28.00
V15 MKIII Recommended retail \$80.00. Our price only \$69.95

BEGINNERS' SPECIALS

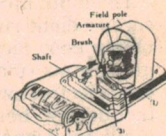
Simple Electrical Kit Packs

These are very easy to build real working models. See how the basic principles work in practice. Three to choose from with full instructions and they are extra easy to build. No soldering needed and will give a lot of fun. Electromagnets pack 80c: Bell \$1.00; Motor \$1.50 (All P & P 50c).



Morse Code Trainer

Produced specially for the forthcoming Novice Licence trainee. Only needs case and battery. All the electronics including a minispeaker and so easy to build \$3.75. Key special at only \$1.50 extra.



Real Superhet Tuner for only \$7.90

Yes, Here's all the basic parts for a 3 transistor superhet tuner. Printed circuit, all coils, ferrite bar antenna, tuning gang, etc. Covers 530 to 1600kHz (thumbwheel dial included). Measures only 45mm by 135mm, ideal for converter IF strip (cheaper than parts alone!). Self-oscillating mixer, 2 stage IF amp with agc into diode detector, NPN transistors and operates off 9V. Why fork out \$20, this one is only \$7.90 (P & P 75c)

NEW ENLARGED AMATEUR SECTION

We are enlarging our Amateur section at Gore Hill. A whole host of new equipment will be on display, much of it for the first time!

Ken KP202 146-148MHz hand-held transceivers 5 channel capacity with 2W output. Telescopic aerial, squelch, provision for ext. aerial and PL259 adaptor plug supplied. Crystals for 3 channels included \$150.00 NiCad charger and 10 cells to suit \$35.00 (Both P & P \$2.00)

Icom IC22 144-148MHz fm transceiver with outputs of 1W and 10W. The 22 channels have separate trimmers. Deviation 5-15kHz. Solid-state Tx/Rx relay, built in speaker, MOSFET front end with 5 helical filters, noise cancelling mic, quick disconnect mobile mount. A great spec and fantastic looks with soft green backlighting etc. Supplied complete with proper manual and even a silicone duster! Normal price is \$245, we're kicking 'em off at only \$189.00 (Insured freight \$3.50 extra)

The Barlow Wadley XCR-30 is the portable communications receiver sensation. If you really must take the best on your picnic then look at this one. Wadley loop as used by the professionals. 0.1uV sensitivity for 17dB sig / noise. Drift less than 70Hz / H, 3kHz selectivity. Full coverage from 0.5 to 31MHz. Come in and see it, you'll buy at \$230 (insured freight FREE)

Hustler aerials expected soon and top flight gear from Yeasu Musen, Kenwood, Hi Gain etc Wide range of crystals for Pony and Sideband hand helds.

Ham Notebook in stock again. From the editors of Ham Radio magazine, this 176 page compendium is compiled from that column in the magazine. It's stacked full of ideas in 10 chapters covering antennas, fm and repeaters, keying oscillators, workshop etc, etc. Good for browsing when the static is bad and only \$4.50.



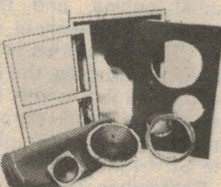
Electronics Centre

NEW BUILD-YOUR-OWN SPEAKER CABINET SYSTEMS FROM \$17.95

Yes you can build a really professional cabinet with these kits because Dick has done all the complicated carpentry for you. Joints are premixed and all cabinets have a beautiful veneer finish. No one will believe you built them, they're that good!! 8ohm speakers. We supply everything including Innerbond, ready for you to start glueing. You can build them in about an hour and just look what you'll save.

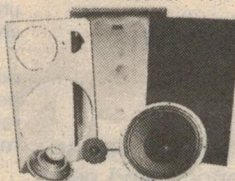
System 1 is intended for our popular Project 250 amplifier system

Features a 6" dual cone wide range speaker and FULLY BUILT Cabinet. Just bolt in the speaker and connect up. Handles 12W peak. Measures 15" x 10" x 7". It's a knock



out at \$17.95 (P&P \$2.50).
System 2 has a 6" Rola or MSP woofer coupled

to a Plessey or Philips dome tweeter. Cabinet is a Bass reflex type measuring 17 1/4" x 10 1/2" x 8 1/2". Handles 20W peak with a response from 50-19000Hz. A



great sound for \$42.50 (P&P Road Freight on).
System 3 features a great big 12" heavy duty

Bass driver and dome tweeter combination. Fully sealed enclosure uses the acoustic suspension principle. Handles 30W rms with a response from 30 to 30,000Hz. Yes a full 2 way 12" system is yours at a fraction of the normal price for just an hour's fun building it. Terrific value at \$49.99 (P&P Road Freight on).
System 4 as system 3 but has sealed midrange unit also \$57.90 (P&P freight on).
X30 dome tweeters cover 3kHz to 30kHz only \$8.90.

Did you see the Trio review in June E.A.?

Quote "Trio have come up with a very attractive range of instruments that will find many applications. They are attractively styled and perform well." Prices include Sales Tax.



VT108 FET VOM 8 ranges 0.5 to 1.5kV, 11Meg input, $\pm 3\%$ accuracy. Ohms from 0.1 to 1000Meg. Memory feature. \$85.



AG202A Audio Generator covers 20Hz to 200kHz 10V rms output. Sine and square wave. External sync. \$94.



CO1303A 75mm Scope has 20mV cm sensitivity covers DC to 1.5MHz Input R & C of 1Meg and 30pF \$170.



SG402 RF Generator covers 100kHz to 30MHz in 6 ranges. Output 0.1V rms. High Low attenuator. Modulation at 400Hz \$76.

Dick Smith 'EICO' Power Supply Kits

Almost every project you build needs a 240V ac power supply, so we've put together some bargain kits. They all include full circuits, instructions, transformer, filter capacitors and all semiconductors. Commonly available parts and metalwork are not included.

PS2VA has a 240 12V ct at 150mA transformer and gives 9 or 19V on open circuit. Typical outputs are 6V at 300mA and 12.6 to 13.6V at 150mA. Ideal for battery saver or NiCad charger, etc, running 9V radios and recorders, etc. \$4.95.

PS15VA uses the PF2155 multitap transformer to give a wide selection of outputs, e.g., 2 to 22V at no load, 4 to 16V at 1A, 6.3V at 1 1/2A and many more. \$7.25 (P&P 75c).

PS121Reg gives 12V dc at 1A, fully regulated and protected by the popular Fairchild 7805 IC. Ideal for projects requiring protection with good regulation and filtering. \$10.25 (P&P \$1.00).

PS5Reg. As the PS121Reg but gives 5V dc at 1A for TTL logic projects, etc. \$10.25 (P&P \$1.00).

PS122Reg is a completely adjustable, regulated supply for 9 to 12.6V dc at 2A and uses a 2N3055 regulator transistor. Ideal for running car stereos in the home. \$19.75 (P&P \$1.50).

PS125Reg is fully regulated to give under 2mV ripple at full load. Adjustable from 9 to 13.8V dc at up to 5A. Ideal for bench supply and operating transistorised 2-Way Radios, etc. Uses 'C' core tranny, 7231C and 2N3055S. Ideal for amateurs to run mobiles from mains. \$27.50 (P&P \$2.50).

Gas detector kit (E.A. June 74) includes posh 1 1/4" SEW movement. Aluminium case with slider on off switch. We have substituted a preset pot and proper battery holders. Only \$15.00 (P&P 75c).



Texas SN76023 IC's

For audio amps (see June '74 EA), only \$2.50.
Circuit board to suit (EA74 SA5) only \$4.00 (both P&P 75c).

NiCad Battery special



Only \$10.50

Limited quantity only of Midland Nickel Cadmium rechargeable batteries. Designed for their Walkie Talkies to give economy for heavy users. Unaffected by idle periods. Can be recharged up to 100 times or more! Cells are hermetically sealed in high impact plastic case. Ideal replacement for equipments using 8 penlight cells. 12V output and 400mA hour capacity. Recharge at 40mA. Measures only 5.6cm x 5.6cm x 3cm, weighs 60z. Fitted with jack socket and 9V transistor battery type connector. Jack supplied with lead and connectors to suit Midland transceivers. Get two — one in use, one on charge. At our price you can afford to!!! Normal retail \$16.50. NOW ONLY \$10.50 or two for \$19.99 (P&P 75c).

High Sensitivity Multimeter Special



This must be Australia's cheapest 20,000ohm/V multimeter having 5 DC voltage ranges, 4 on AC, 2 DC current ranges and 2 resistance ranges. 34uA high sensitivity movement. Big, clear scale. Off position for safety 3% DC accuracy. Normal Retail Price is \$17.50, a few discounters have them at \$15.00. Please support our bulk purchase (it's in your interest) ONLY \$10.50. Yes Ten dollars fifty!! (P&P \$1.00).

20,000 Ohm/V

ONLY \$10.50



Ferrite Toroids



Only while they last since we have purchased the entire stock of a well known manufacturer. Ideal for speaker lead suppressors (see June E.A.). Q1 material 2-30MHz, Q2 10-40MHz please specify

Type	diam	Material	Price
F4021/2	0.71"	Q2	70c each
F4041/2	0.65"	Q1 or Q2	65c each
F4040/2	0.455"	Q1 or Q2	60c each

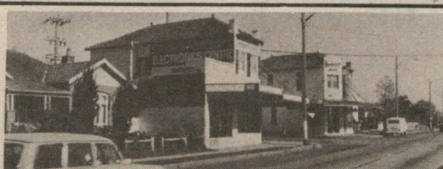
Ferranti ZN414 Microradio IC kit



(as featured in Electronics 'Australia' May 74). At last you can build a true miniature radio. IC features a 10 transistor circuit which requires only tuned circuit and 3 parts. 72db gain. Operates on 1.5V and only 300uA. We've seen one in half a matchbox, can you beat it? No case supplied because you'll want to build it your way. Minikit still available on special offer at only \$6.75 (see article).

Can you hear the fridge on your Hi Fi?

Then get one of our Label Line Filters which are ideal for removing noise from fridges and other electrical appliances, etc. 480W rating (2A at 240V). Ready to plug in for only \$16.50 (P&P \$1.00).



AWA Clarion Car Cassette Stereo Offer

Frequency response 50-10,000Hz; more than 4.5W output per channel; 2 ICs, 10 transistors and 1 diode; only 140mm x 55mm x 150mm; complete with HD 6" high compliance speakers. Normal price is \$109. Hurry and get them at the old price \$79.70 (yes with speakers! P&P \$2.50).



New stocks of Pioneer Car Stereo Speakers

Improves the sound quality of any stereo or radio giving crisper definition and added depth.

Model T-100 (flushmount). Twin cone 5" unit; massive 1/2lb magnet; exclusive 'hydroflector' to repel moisture. Handles 8W max at 40hms. Only \$21.50 a pair.

Model TS160 (flushmount). Full range 6" twin cone; 1/2lb magnet; 40-20,000Hz; unique centre cone dust deflector; free beating high compliance cone. Only \$26.95.

Fully built and Tested Power Supply 12.6V at 3A fully regulated with overload protection, etc. Intended for ac operation of mobile radios including 5W 27MHz transceivers, etc. \$32.00 (P&P \$1.50).

Tools Expo drills in stock again



All the way from England and used by jewellers, etc. Will grind, drill, saw, burr, polish, brush, etc. 9,000rpm minimotor runs off safe 12V dc. Extremely popular and we now have the various parts as follows—

Complete kit, drill and 20 assorted tools, \$22.95.
Drill stand \$21.50, drill packs (grinding wheels, burs, brushes, polishers, etc), state which, \$2.49
Titan Minidrill only \$14.00.

PC Board drills. Morse drills size 30, 35c; 55, 30c; 60, 30c; 65, 32c (P&P 30c). Get the set for only \$1.20 (P&P free).

Dato Pens contain ink immune to etchants. Draw the pattern on your PCB, let it dry for 15 mins, etc, then remove ink with solvent. Experimenters' dream. Note this is a pen full of ink, not a pad. Reliable valve action. Spare tip included \$1.75, solvent 80c, etc \$1.00.

Chassis Bashers. We now have a proper bender. Handles up to 21 gauge and a width of 18in. Well worth \$31.50 (P&P Road Freight).

Photocell Experimenter's Kits

(see E.A. March '73)



Contains a selection of photovoltaic and photoconductive cells which are overruns from famous US manufacturer. Kits are not therefore identical, but all are outstanding value since the cells are a fraction of their normal cost. Comprehensive manual supplied with every kit. Average content is 7 cells for \$10.95 (P&P 50c).

ABOVE
NEW BANKSTOWN CENTRE ONLY 100 METRES FROM CHAPEL ROAD



Forum

Conducted by Neville Williams

"Seedy eye" on capacitor discharge ignition

CDI — capacitor discharge ignition — continues to be a subject of debate amongst electronic enthusiasts. To some, it is the key to economy and performance, the best thing that's happened to motoring since electric headlamps. To others, the whole idea is a load of unmitigated codswallop, whatever that may be!

As a contribution to the argument, we have to hand a letter from a reader in Padstow, NSW. From a background of instrumented tests, he has this to say:

Dear Sir,

It has been amusing to read the variety of articles and comments on electronic ignition in both this and other publications. Most are pro CDI but all lack concrete documented evidence. Surely the most effective way to evaluate ignition systems is by using an ignition analyser and an engine dynamometer to measure engine performance.

Evaluation along these lines was carried out by the writer using:

- (1) A Ford Falcon 6-cylinder engine coupled to an engine dynamometer, and
- (2) A Holden 6-cylinder engine coupled to a Vane Tunescope Analyser, model 3090.

The dynamometer measures torque in foot-pounds with relation to rpm. Horsepower may be calculated from this by dividing torque times rpm by 5250.

The Tunescope Analyser enables primary and secondary voltage waveforms to be observed on a large-screen CRO, and has provision to monitor the air-fuel ratio.

The CDI used for these tests used a 1uF oil-filled capacitor supplied with 400 volts from the DC converter at an engine speed of 2000 rpm. The SCR trigger signal is delayed for 60 microseconds using a unijunction transistor to match the rise-time of the ignition coil when using conventional ignition. This eliminates timing errors between the two systems, and its effectiveness was confirmed with the Tunescope Analyser.

The Holden engine used a stock Lucas "cold-start" coil with a 80 / 1 turns ratio, a primary DC resistance of 1.5 ohms, and a 50Hz impedance of 7.9 millihenries. Cold start coils of this type are now used almost universally on modern cars, so that no new car (in tune) should exhibit starting difficulties.

The accompanying graph shows the torque characteristic using conventional and capacitive discharge ignition systems. The dynamometer could not accommodate speeds in excess of 3000rpm, but it showed an improvement of 7pc at 2500rpm when using CDI. This improvement could be

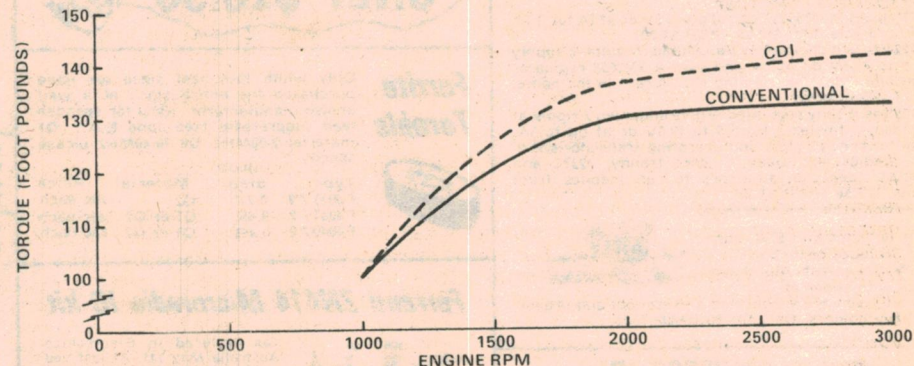
compared with replacing an engine of 1500cc with one of 1600cc capacity.

Measured results from the Tunescope Analyser are set out below:

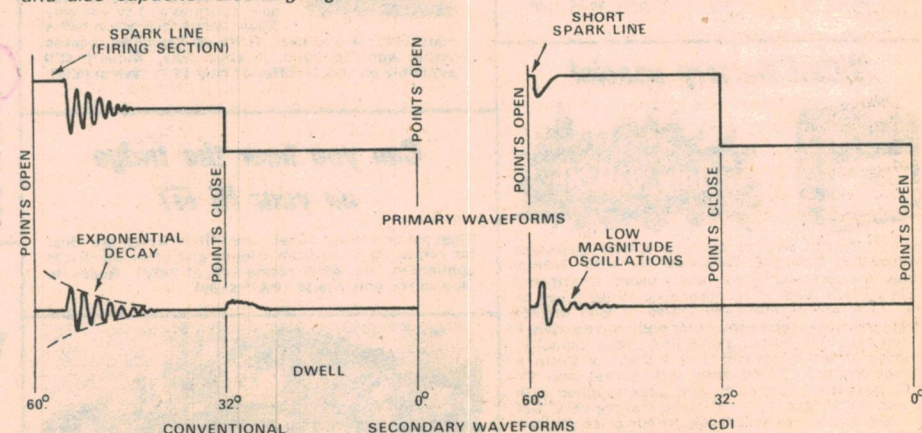
Open-Circuit Coil Voltage:		
600rpm	28kV norm.	32kV CDI
2000rpm	28kV norm.	30kV CDI
4000rpm	23kV norm.	30kV CDI

Plug Firing Voltage (0.032in gap):

600rpm	9kV norm.	7kV CDI
2000rpm	5kV norm.	5kV CDI



A plot of torque against engine speed for a Ford Falcon 6-cylinder engine, with conventional and also capacitor discharge ignition.



Primary waveforms (top) and secondary waveforms (below) observed on a Holden 6-cylinder engine with conventional and CD ignition.

Spark Line Length:
1500rpm 5deg norm. less than 1 deg CDI

Air-Fuel Ratio:
600rpm 13:1 norm 13:1 CDI
2000rpm 13.5:1 13.5:1
3000rpm 14.5:1 14.5:1

Note that although the CDI gives almost constant coil open circuit voltage, this has no relationship to the spark plug firing voltage which depends upon spark plug gap, the air-fuel ratio, the gas pressure and temperature. The test was carried out on an unloaded engine, and the air-fuel ratio showed no improvement with CDI.

The CRO waveforms are reproduced for comparison purposes, the major differences being in spark line length (which is directly related to the spark duration) and in the magnitude and number of oscillations.

The SCR Ignition Booster (Mr A. Kethel E.A. September 73) seemed an excellent idea, but when tested on the Tunescope Analyser, the coil open-circuit voltage was found to be some 2kV lower than that obtained from the conventional coil. This reduction in voltage can be attributed to reduced coil current caused by the voltage drop (about 1.2 volts) across the SCR which is in series with the coil. Furthermore, like the CDI, no variation in air-fuel ratio was observed.

Incidentally, I do not use CDI on my car, as it does not give a noticeable improvement over the original ignition system. After all, how does one improve the starting ability of a car which starts first time every time?

B.F. (Padstow, NSW)

That last sentence is very eloquent. B.F. is obviously in a position to have CDI in his car if he wanted it but he hasn't bothered

with it because he doesn't have an urgent problem that needs to be solved. Nor, apparently, does he feel that any benefits that might accrue from using CDI are sufficient to overcome objections of cost, complexity, and the rendering of a vehicle "non-standard" from the servicing viewpoint.

On the other hand, we recall the contrasting decision of a tech college teacher, with access to similar testing facilities, who did install CDI in his car.

But he had a problem to solve: The car was one which did not take kindly to wet conditions and to driving rain in particular. The risk of electronic breakdown was far lower than that due to moisture on the ignition system as fitted and the extra kV which a CDI gave system made all the difference in his particular case.

Component Supply

To change the subject, here's a letter from a serviceman who has generated some strong feeling about the component supply position. He says:

Dear Sir,

I refer to your recent observations about parts shortages and I must agree with your sentiments about the diversity of available components.

Surely the hobbyist can get by with a standardised "point one" capacitor. Surely such things as resistors and capacitors can be standardised. How many projects in the past couple of years have you described where metal film or metal glazed resistors were needed. Yet some hobbyists, with more money than sense, insist on getting these bits and create a scene when they cannot get them!

I personally work in the TV servicing industry and I find it frustrating in the extreme when I cannot get the necessary spares — but that isn't the same problem.

If I want to build a "state-of-the-art whatnot" and I find that some of the bits are out of stock then, while I may be crook, I can at least understand the situation. And I'm the only one concerned.

But you try to tell Joe Customer that you can't get valves, changeover tuners, EHT transformers, knobs, certain capacitors or resistors and he goes through the roof! One particular manufacturer has been making solid state TV sets for a year now. But you try to get the horizontal output transistor. No go, and even if you could, it costs the best part of six bucks. This in a much-vaunted transistorised set, supposedly ultrareliable!

In my experience, transistors are okay for small signal stuff; perfect for IF, tuner, AGC and sound. But try to put them in the power stages, Hos and Vert output and all Hell breaks loose!

And take the humble switchback pot. Millions of them are made per year, and they're almost a standard item in every set. But the news has just filtered through that they won't be made any more. Instead of just replacing the switch back we have to change the entire pot. Some of these pots cost us seven bucks each. Good business, of course, but the sort of thing to make the blood of any decent technician boil.

It's hard enough now to satisfy a customer, considering labour costs, and this will make the customer even surer that we are a pack of thieves.

6CM5's? Can't get 'em! I checked back through my call records and there are thirty-one sets attended to by me which are still not repaired, because they need 6CM5's

and I can't get them. Some of these sets have been like this for four months. What do I do? Lose the customer? Most likely!

And who do I blame for this shortage? Myself? The supplier? No. He's just as much worried about it as I am. It must come squarely back to the manufacturer. Now I don't expect them to react to a shortage within a week. They've got to set up a production line for each valve and I can hardly expect them to halt one line already set up and change over to another valve. But four months? Surely it doesn't take that long!

Ask "The Serviceman" if he's had any trouble. His troubles may not be the same as mine but he most certainly has had a lot of calls wasted by a lack of spares.

Just what do we do about it? Complain to the suppliers? I don't think that will solve anything, for he's just as likely to jack up at us. What is needed is direct agitation to the manufacturers by all sections of the trade, including your magazine.

If this goes on any longer, I'll become a blacksmith.

R.M. (St Albans, Vic)

A blacksmith! What's a blacksmith?

Fairly obviously R.M. doesn't really spend too much of his time building "state-of-the-art whatnots", otherwise he would not be quite so convinced about the practicability of using non-state-of-the-art components.

One could find plenty of examples but one that comes to mind is the little SQ decoder that was included in the Playmaster 140 quadrasonic amplifier. With an IC and miniature peripheral components, the whole thing could fit comfortably in the palm of the hand. More importantly, it fitted comfortably into a convenient space in the standard chassis. Try to build that some gadget without the IC, or even just using large size components, and it would have become a real headache.

One might even go on to suggest two definitions for misery (from the hobbyist viewpoint):

"Misery is trying to fit conventional point-ones on to a board designed for miniature polyesters" or

"Misery is having to make a complex gadget several times larger than necessary because you can't get the right parts."

But, of course, R.M. is right enough when he points out that a serviceman's lot is not a happy one. (Where have I heard that before?). His misery extends to his customer and, in the ultimate perhaps, to his banker.

Whether R.M. should blame the manufacturer for his problems is another matter. In some cases it may be justified, but those cases are being overshadowed by much more momentous circumstances.

All around Australia, component manufacturing lines are phasing down as the result of lowered tariffs. If we can't mass produce components cheaply enough to compete with imports, we certainly won't be able to produce economical spares a few at a time.

Maybe we should raise the sights to the politicians who re-shaped the tariff levels!

In the meantime, we'll leave the subject open, to see what you think.

FOOTNOTE: I happened to encounter an executive from IRH who said that his company, at least, had no immediate intention of cutting off the supply of switch backs. Maybe that will make R. M. feel just a little less miserable!

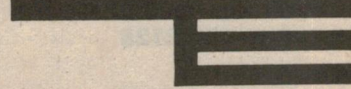
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30mA 300mA 12A (300mV)
Ohms: Range x1
x100 x1k x10k Midscale -
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A crystal locked musical tone generator

Here's a project that should, once and for all, resolve the uncertainties of musical pitch. Though presented here as a tuning standard, with every note under firm crystal control it offers the potential of crystal locking existing organs, as well as being a possible tone source for synthesisers and computer-controlled music generators.

by DAVID EDWARDS

Primarily, the aim of the present project is to simplify the problem which faces enthusiasts and musicians of tuning their instruments in a precise and uniform manner. Perhaps a little background would be helpful:

Before the era of electronic instruments, tuning pianos and organs in particular was regarded as something of an art, understood and practised by relatively few people. It involved setting the frequency of a single note with the aid of a tuning fork or pitch pipe, then setting up one complete basic octave, by playing pairs of notes in a particular sequence and reacting to the beats between them.

The basic adjustment would then be extended over the whole keyboard, till the necessarily noisy job was finished.

However, over the past 25 years or so, the realm of music making has been invaded by scientists and engineers — short on mystique but strong on mathematics! They pinned down the formerly errant musical pitch to a precise $A = 440\text{Hz}$. Then, by dividing the octave of the tempered scale into its 12 precise intervals, they nominated the frequency of each semitone correct to several decimal places.

Against this background, the job of tuning electronic instruments at least should have become merely a matter of turning a knob or reading a meter but, at a practical level, it hasn't been as easy as this.

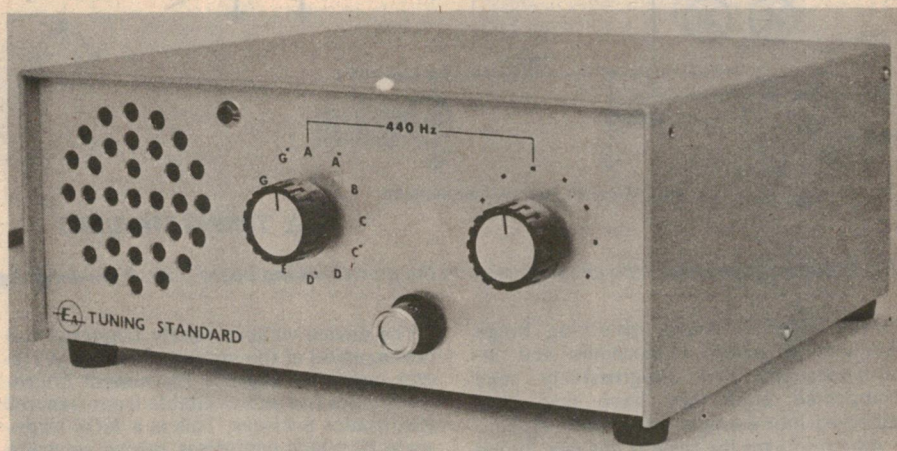
The technology behind audio generators, frequency meters and such like, while more than adequate for amplifier testing, has lacked the precision necessary to set the intervals of the musical scale. Even those instruments especially designed as electronic tuning aids have tended to rely on extrapolation from a single reference somewhere within their range. They have lacked the assurance that every single interval was individually and permanently locked to a reliable standard.

One possibility that was considered some years ago was to have a set of precision crystals, in a semitone relationship, with a

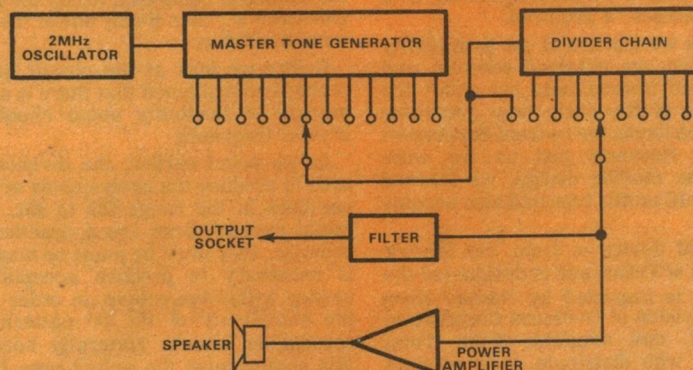
divider chain capable of reducing the selected crystal frequency to the corresponding musical pitch. But, for most enthusiasts, it was fated never to be more than a possibility, because of the cost of the crystals required.

With the evolution of more sophisticated divider circuitry, it became feasible to envisage a single, stable high frequency oscillator and divider chains set up for selected whole numbers, which would divide the one source frequency to audio tones closely approximating semitone intervals.

Calculation showed that a very convenient frequency for a master oscillator would be 1.999360MHz — a frequency for which good quality crystals can be ground relatively cheaply. This can be divided down to frequencies suitable for the top octave of a typical instrument by a series of whole numbers, as follows: C, 239; B, 253; A sharp, 268; A, 284; G sharp, 301; G, 319; F sharp, 338; F, 358; E, 379; D sharp, 402; D, 426; C sharp, 451.



Below is a block diagram showing the basic circuit configuration. A master tone generator outputs twelve semitones to a divider chain capable of dividing each semitone by up to eight octaves. Above is the completed prototype.



While an intriguing possibility, it posed the very practical problem, initially, of requiring far too many discrete components to be the basis of a "handy" tuning aid.

Faced with this, we looked at the alternative, several years ago, of using a single divider chain, but switching the logic circuitry to produce one semitone at a time, as required. But the problem then became one of wiring complexity, along with the cost of the necessary switch.

In consequence, it stayed in the "too hard" basket. At least, until we received the article by S. H. Dolding, which we published in the May issue. The design presented in that article used seven ICs, and a diode matrix to simplify switching.

More recently, the designers of integrated circuits have addressed themselves to the problem, prompted in particular by the demands of electronic organ manufac-

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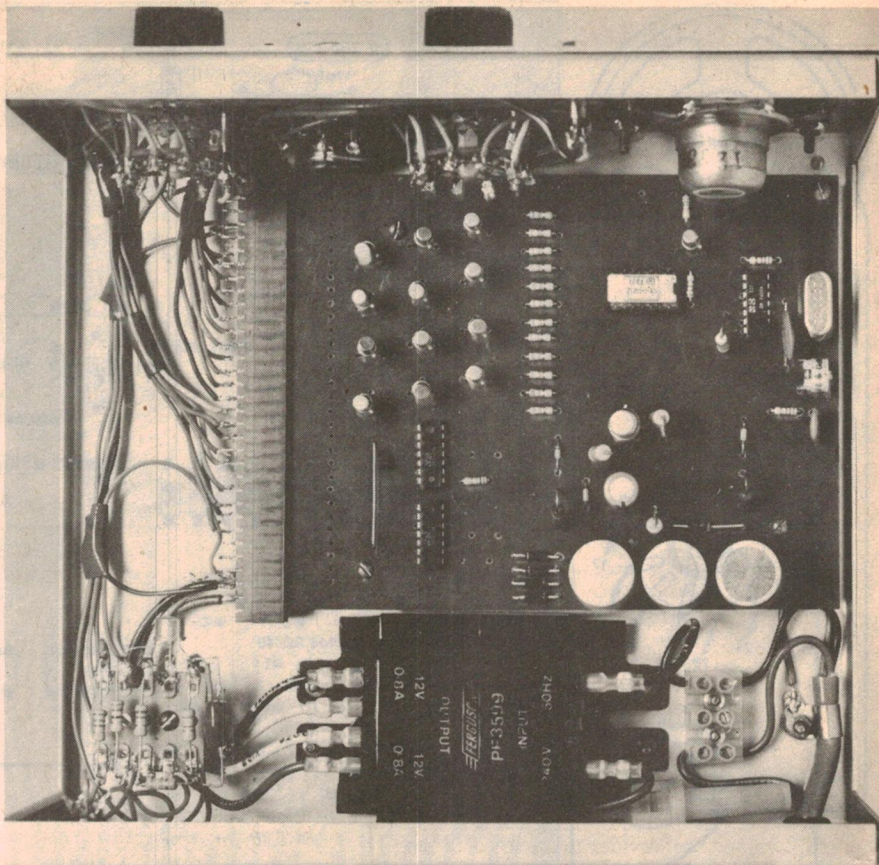
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This interior view of the completed prototype clearly shows the disposition of all the major components, the tagstrip, and the printed wiring board.

However, we have made provision for the use of circuit board pins and directly soldered on leads. We made our prototype using the edge connector, as this made frequent removal and replacement quite easy.

The AY-1-0212 device requires supply voltages of +12V plus or minus 1V to pin 1, 0V to pin 10 and -15.5V plus or minus 1.5V to pin 9. Pin 2 is the input connection, and the twelve outputs are available from the remaining pins.

The printed circuit board was designed to supply these voltages to the AY-1-0212, using three separate zener diode referenced supplies working from a transformer with two 12V secondaries.

The MK50242 only requires a single supply rail. The recommended supply voltage ranges from +11V to +16V, with a typical value being +15V. It is thus possible to use the same +12V supply as required by the AY-1-0212. The components required for the -15.5V supply can be left off the board as they are not needed, giving a small saving in cost. This is partially offset by the increased price of the MK50242 as compared with the AY-1-0212.

The crystal oscillator circuit is basically the same as in the 200MHz counter. This consists of a 7400 quad gate wired in the manner recommended by Foster and Rankin in their article of November 1972. We have used the fourth gate to provide a buffered auxiliary output, so that if required the 2MHz output would be available for use with any other equipment.

Provision has been made on the printed board for a trimmer capacitor to adjust the frequency of the crystal oscillator. However this will not normally be required in the

present application. In place of the trimmer and its shunt capacitor, the circuit should normally be wired with a single 33pF NPO ceramic capacitor in series with the crystal, as shown in the circuit.

The connection between the crystal oscillator output and the input circuitry of the tone generator IC is made via a small copper link, both ends of which are brought out. If an alternative 2MHz signal is available, then this link can be broken, and the signal fed in through the relevant connection. If, after breaking this link, it is required intact once more, then provision has been made to use a wire strap to bridge the gap.

The input circuitry to the tone generator IC consists of an impedance and voltage matching stage consisting of a single transistor, working in the common emitter mode. The main function of this stage is to increase the signal level to that required by the MOS device.

Each of the twelve outputs of the IC need to be converted back down to a suitable level for inputting to the TTL dividers. Because of the risk of damage to the IC, it was decided to use twelve separate buffer stages followed by the selector switch, rather than using one stage after the switch. However, since only one output is required at any one time, we were able to use a common collector resistor.

As all these stages are working at less than 10kHz, no special transistors are required. Almost any general purpose audio or switching transistor will be satisfactory, provided that the gain is high enough. The twelve base resistors required need only be ¼ watt types.

A twelve position single pole rotary

TONE GENERATOR

switch is used to select which note is to be fed to the dividers. We used a make before break type which we modified by removing the spindle stop, allowing the shaft to rotate completely. This allows easier selection of the notes.

From the note selection switch, the signal passes to the dividing chain, consisting of the two 7493 TTL binary counters wired in series. These give eight octaves of notes additional to those obtained from the tone generator IC, selected by another twelve position single pole rotary switch. Only nine of the positions of this switch are actually used, the remainder being left unconnected.

The 7493 counters incorporate a reset function controlled by a dual input nand gate. The inputs to this gate must be connected to a low logic level before the counter will operate. When they are connected to a high logic level, the counter is reset.

We have connected both inputs to the nand gate permanently together, and joined them to a spare output connection, so that the reset function may be used if required. A small copper link on the pattern is used to make the connection to ground so that the counter will operate. If it is required to reset the gates, this connection must be broken. Provision has been made to remake the connection with a wire link if required.

A wire link is required to connect the output of the first divider to the input of the second. Both dividers have been arranged so that they may be used independently of each other, if this is required. Provision has also been made for the collector load resistor of the tone generator buffer stages to be used with either divider.

These provisions are not particularly relevant in connection with the present project, but are designed with future applications in mind.

As detailed earlier, for the AY-1-0212 we require supply voltages of +12V and -15V. A +5V, 150mA supply is also required to drive the TTL logic, and also to drive the output device. We have used a power transformer having two 12V secondaries connected to form a 24V centre-tapped winding, in conjunction with two back-to-back full wave rectifiers to supply voltages of plus and minus 17V, after filtering by two 1000uF electrolytic capacitors.

The -15V supply is obtained using a 400mW zener diode in conjunction with a series resistor. It is possible to use either a 14, 15 or 16V diode, since the actual voltage is not critical.

To prevent possible interaction between the MOS and TTL logic, the +12V supply is decoupled from the +5V supply using a diode and another 1000uF electrolytic capacitor. The +12V supply consists of a 400mW zener diode and a series resistor, and is similar to the -15V supply, except that the diode should be a 12V type. (This supply is more critical than the -15V line.)

The +5V supply for the TTL logic uses a 5.6V 400mW zener diode in conjunction with a 1 watt general purpose transistor. A 100uF electrolytic in parallel with the zener diode is used to improve the ripple rejection.

This supply has been brought out to one of the output connectors on the board, so that it can be used to drive the output devices. Alternatively, if another +5V supply is available, then the relevant components

LIST OF COMPONENT PARTS

- 1 Case, 230 x 215 x 90mm, with matching front panel
- 1 Power transformer, 240V to 12V and 12V at 0.8A.
(Ferguson type PF3599 or similar).
- 1 Printed wiring board, 74/09 (125 x 167mm)
- 2 Rotary switches, 12 position single pole
- 1 2MHz quartz crystal, AT-cut fundamental
- 1 70 mm dia, 15 ohm speaker. (Rola 2C or similar)
- 1 16 pin DIL integrated circuit socket
- 1 32 way 0.150 inch pitch edge connector (McMurdo Redline or similar)
- 1 6V Pilot light
- 1 3 pin DIN socket
- 1 1k linear potentiometer
- 1 Miniature tag board, 5 prs. tag
- 1 Mains cord, plug, rubber grommet and clamp
- 1 1A fuse and in-line fuse holder
- 3 knobs
- 1 3 terminal block

SEMICONDUCTORS

- 1 Tone generator IC, AY-1-0212 or MK50242 (see text)
- 1 7400 quad nand gate
- 2 7493 4 bit binary counters
- 2 NPN 1 watt transistors, TT801, 2N3053, BFY50 or similar
- 14 NPN 300 milliwatt transistors, BC108, BC548, or similar
- 1 12V, 400mW zener diode, BZX79/C12 or similar
- 1 5.6V, 400mW zener diode, BZX79/C5V6 or similar
- 1 15V, 400mW zener diode, BZX79/C15 or similar (AY-1-0212 only, see text).
- 3 Silicon diodes, EM401 or similar

- 2 Silicon diodes, EM401 or similar (AY-1-0212 only)

CAPACITORS

- 2 1000uF, 25VW electrolytics, printed circuit board types
- 1 1000uF, 25VW electrolytic, printed circuit board type (AY-1-0212 only)
- 1 100uF, 12VW electrolytic, printed circuit board type
- 1 0.1uF polyester
- 1 33pF NPO ceramic
- 1 47pF NPO ceramic

RESISTORS (all 1/4 watt unless specified otherwise)

- 1 22 ohm, 1 watt
- 1 22 ohm
- 1 27 ohm, 1 watt
- 1 100 ohm, 1 watt
- 1 150 ohm
- 1 180 ohm, 1/2 watt
- 1 390 ohm (AY-1-0212 only)
- 1 680 ohm
- 1 1k
- 3 1.8k
- 1 2.2k
- 1 10k
- 13 39k
- 1 120k

MISCELLANEOUS

Rubber feet for case, multicoloured hook-up wire, insulated spacers, machine screws and nuts, washers, self tapping screws.

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used in our prototype. Components with higher ratings may generally be used if physically compatible. Components with lower ratings may be used in some cases, if ratings are not exceeded.

may be left off the board, and the +5V applied to the connection.

Note that if the MK50242 is being used then the -15V supply is not required. The relevant components may simply be left out.

We have provided two distinct output facilities for the tuning instrument. A small speaker serves to give an audible output, so that instruments may be tuned by listening for beat notes. This is driven by a Darlington pair, acting as a switch. This arrangement is very efficient, giving a quite reasonable amount of sound while only drawing 30mA from the +5V supply. It does have the disadvantage that the speaker is being activated by a square wave, but we have not found that this causes any great difficulty.

The second output facility is a 3-pin DIN socket on the rear of the chassis. The output signal is filtered and attenuated before being supplied to it, so that the level is suitable for feeding into the auxiliary input of a stereo amplifier, or into the input circuitry of a CRO or similar device.

Before we progress to deal with the construction, a word of warning is perhaps in order concerning MOS devices. MOS devices are susceptible to damage caused by stray electrostatic charges, so that unless reasonable handling precautions are observed, the devices may be rendered inoperative.

To protect the devices during shipment, they are packed in conductive foam. Do not

remove your device from its packaging until you are ready to install it in its socket. We will give details of the procedure to be followed in actually installing the device further on in the article.

Construction of the tuner is relatively simple, as most of the components are mounted on the circuit board. Before any components are placed on the board, it should be carefully inspected for any breaks in any of the copper tracks or bridges between them.

Once this has been done, the wire strap can be fitted, followed by the resistors and capacitors.

All 1/4 watt resistors will fit to the board in the normal horizontal position, but the 1 watt types need to be stood on end. If 1/4 watt resistors cannot be obtained, then larger types may be used standing up. Take care when mounting the electrolytic capacitors that their polarity is correct, as shown on the printed board-overlay.

The power supply components can now be fitted. Ensure that the zener diodes are fitted with the correct orientation, as shown on the overlay. The fourteen transistors are best fitted next. Do not apply excessive heat as this may damage them.

The socket for the tone generator IC is the next component to be fitted. When fitting the three TTL IC's, take particular care that they are fitted with the correct orientation, and in the correct place. Use a

(Continued on page 115)

Designing a quartz crystal controlled clock

Using a quartz crystal oscillator as the basis for timekeeping gives a considerable improvement in reliability over that obtainable when using the mains frequency as reference. It also provides the opportunity to make the clock independent of mains power. There are problems associated with minimising power consumption, but if these are solved as discussed here, the result can be a very attractive timepiece.

by IAN POGSON

In June and July, 1969, we described a Crystal Drive Unit for Clocks. This was done in response to many requests for a crystal clock, and although we realised that there were many problems associated with such a venture at the time, we "had a go." Although it worked reasonably well the resultant circuit had a number of shortcomings and fell short of what we would have liked.

Ever since then, I have been looking for ways out of problems which were manifested in the unit originally described. One major problem was that there seemed to be no immediate answer to an economical readout device. It may be remembered that we originally used an ordinary 50Hz synchronous clock movement. This required between one and two watts of power to drive it and necessitated an audio amplifier with consequent relatively high power consumption. This was of the order of 250mA at 12 volts — hardly a proposition where battery operation is envisaged.

The overall approach to frequency division was reviewed also. In order to get maximum reliability, flip-flops should be used, but as they each only divide by two, it means that a large number of stages would be needed to divide from say 100kHz, or thereabouts. And the more stages used, the higher climbs the current consumption.

On the other hand, it can be shown that if we use free running multivibrators for at least some of the divisions, keeping these divisions to a low figure, excellent reliability can still be achieved. This approach, using astable multivibrators for dividing by other than two, and by using flip-flops to do the divisions by two, is the approach which has been adopted.

Before proceeding further with discussion on design philosophy, perhaps it would be a good idea to set out what sort of specification I had in mind and so endeavoured to achieve. The unit shall be battery operated, from one or two dry cells (1.5 to 3V) and at a current consumption of about one milliamp or so. Under these conditions, one or two dry

cells would last around one year. Although this seemed an idealistic approach, I felt that it could be done. I had already developed a crystal oscillator and divider chain which could be operated at 3.6V and a couple of milliamps. Perhaps this could be reduced still further, but the big problem was the readout.

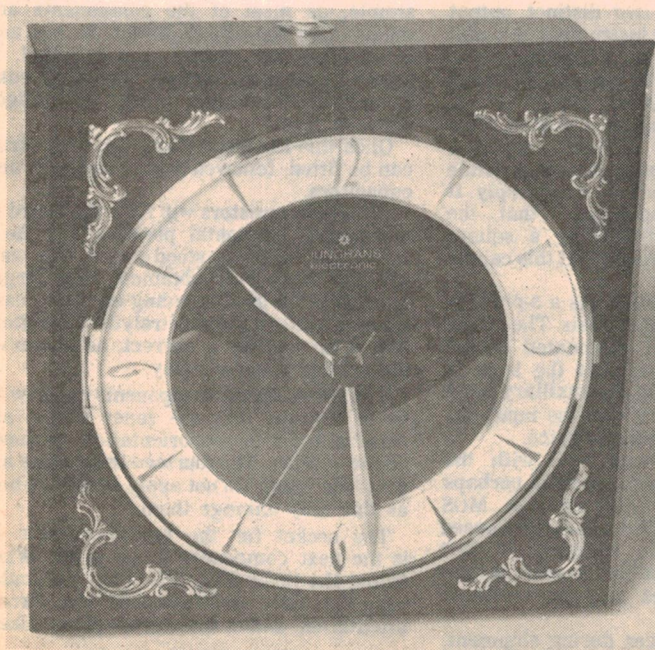
Between eighteen months and two years ago, I was studying some technical information given for battery operated, transistor switched, clock movements. Clocks with these movements are very common and use a balance wheel oscillating at a standard rate of five beats per second; but instead of the usual mechanical escapement, an electromagnetic, transistor switched system is used. This results in a very reliable system and requires one dry cell with a current consumption of about 200 microamps.

One table in the technical information just referred to, showed the variation in rate with applied battery voltage. By changing the battery voltage between say 1.7V and 1.3V, the rate of the movement would change by several seconds per day. One example indicated that with 1.7V, the rate was +8 seconds per day, through to -5 seconds per day with 1.3V. This seemed to be a clue to the solution of the readout problem which I had been looking for. The next problem was how could this characteristic be exploited?

A preliminary check which I made, varying the supply voltage to a typical movement bore out the figures set out in the table referred to earlier. It therefore seemed likely that some sort of servo system making use of this voltage versus rate characteristic might be the answer to the readout problem, thus making it possible to use one of these clock movements as the readout.

After much thought and work with a scratch-pad, the idea of superimposing a square wave at 5Hz on the nominal 1.5V DC supply was considered worth trying. The square wave could have a peak-to-peak value of about one volt. This would mean that the supply to the movement would be varying between one volt and two volts, at a 5Hz rate.

When applied to the clock, the theory was that if the movement was being effectively fed with one volt, according to the table, the clock would lose. As the square wave being fed to the clock was controlled precisely by a crystal, the movement would slide with respect to the supply rate and so it would then find itself looking at the high voltage part of the waveform. This would cause the clock to gain, and so the movement would hunt between the two supply voltages. Provided the movement was regulated within the control range, the clock would



This movement from Junghans, built into a handsome wood-grained case, has been used in the prototype crystal controlled clock to be described in the near future.

keep time under the control of the crystal.

The idea was tried and it was found that the clock movement was in fact under the control of the crystal. This account is perhaps an oversimplification of the facts but suffice to say that at this point, the results were most encouraging and well worth being pursued further.

It was reasoned that the synchronising phenomenon should be observable on a CRO. This proved to be so, but after some investigation, it was found that the hunting theory was not correct — although it was obvious that the two frequency components remained synchronised. The clock movement takes its energy from the battery in the form of five pulses per second, each pulse being about 15mS in duration. This pulse straddles one or other of the edges of the 5Hz square wave from the supply system and the phase relationship remains in this mode.

Having observed this effect, the question arises as to just by what mechanism does synchronising take place? I can only offer a suggestion, which is that the clock pulse straddles the edge of the supply square wave in such a fashion that a proportion of the normal pulse fed to the movement varies with rate, thus keeping the clock movement precisely in lock with the supply frequency.

Regardless of the correctness or otherwise of this theory, it would seem that we have a case of two frequencies close to each other, coming into lock. As one frequency is fixed, the other (the clock) is the one which moves and locks in.

The basic system just described has proved to be successful and units have been operated under these conditions for months at a time. However, 5Hz is a very low frequency and when a 5Hz square wave had to be considered, it became doubly difficult to handle. As the pulse taken by the clock is only about 15mS wide, as mentioned earlier, the thought came to mind that a 5Hz supply was not essential. Instead, multiples of 5Hz could be used just as effectively, provided we did not use a frequency with a half-period of less than 15mS. A square wave at 25Hz has a half width of 20mS, so that theoretically the clock pulse could lock on any one of the edges just as effectively as before.

This setup was easy to arrange and it was soon established that the theory was correct: locking took place just as predicted. By taking this approach we eliminated many of the low frequency problems. Less frequency division was required and less current drain as well. This is therefore the approach which we have adopted.

Before proceeding further, there is one point which should be brought out. Due to the rather sluggish mechanical nature of the five beats per second balance wheel movement which we have been able to synchronise successfully, there is the matter of portability. If the movement is shifted about as in a portable situation, it may be that the oscillations of the balance wheel may be interfered with slightly and synchronisation may be lost temporarily, with a consequent loss of accurate readout.

This is only a theory on my part and hopefully it may be wrong, as I have not put it to the test. If the unit is picked up more or less gently and moved from one place to another, there seem to be no ill effects. The idea that vigorous movement may upset it is just a word of caution.

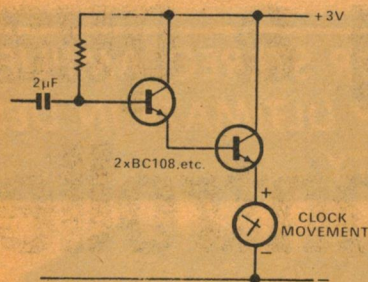


FIG. 1

A square wave pulse applied to a Darlington pair configuration will effectively synchronise a clock movement. Figs 1 and 2 show alternative circuits.

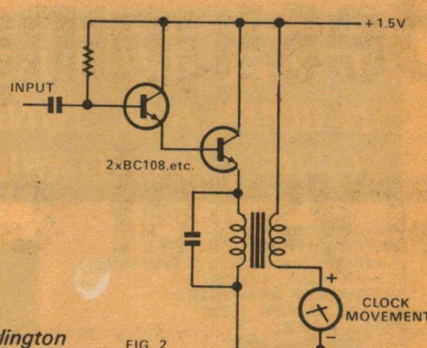


FIG. 2

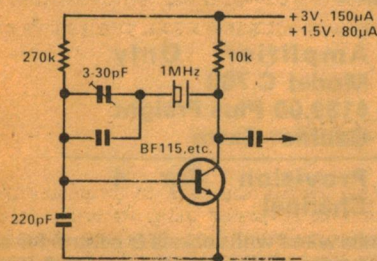


FIG. 3

Two simple crystal oscillator circuits suitable for 1MHz crystals and 100kHz crystals are shown in Figs 3 and 4 respectively.

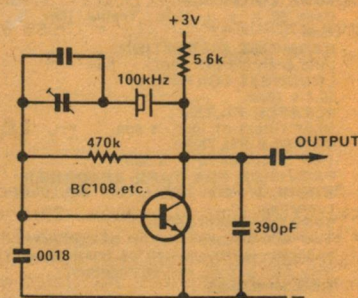


FIG. 4

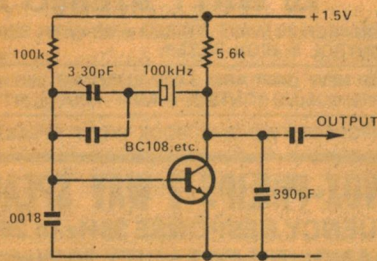


FIG. 5

A suitable circuit for 100kHz crystals and 1.5V operation is shown in Fig 5. Fig 6 shows a more elaborate circuit.

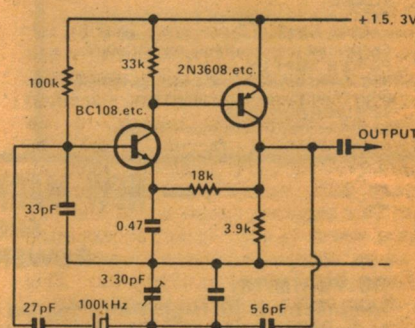


FIG. 6

Initial development of the foregoing system was done with two 6kHz crystals which happened to be on hand. The low frequency made division that much easier but other crystal frequencies could be used and adapted to our purpose. More will be said later on about crystals. Apart from the work associated with the technique of synchronising the clock movement, a considerable amount of work has also been necessary to establish suitable crystal oscillators, astable multivibrators and flip-flops as dividers, and a suitable method of driving the clock movement.

In the early stages, it was considered satisfactory to operate the whole system from a 3V supply and with a current drain of about 1mA or so. In some respects, 3V allowed circuits which were somewhat more economical with respect to components, when compared with some changes which had to be made so that 1.5V operation would be possible. Both aspects will be dealt with and readers may adopt whichever approach they feel suits their particular purpose.

In this first article, it is proposed to deal with basic circuits so that the experienced

reader may tailor his own design. In a later article, we will describe a complete crystal clock unit, with full constructional details.

In order to put the synchronising system into effect, we must meet two requirements with respect to feeding the clock movement. A DC supply nominally at 1.5V is needed to meet the basic supply need of the movement and to synchronise it the 25Hz square wave signal must also be fed to the movement.

This is achieved in the 3V version with a Darlington pair, the clock movement being connected between the second emitter and the negative terminal of the battery. This supplies DC at 3V minus 1.2V, resulting in about 1.8V available for the movement, when new batteries are fitted.

The 25Hz synchronising signal from the crystal source and divider chain, is fed into the first base of the Darlington pair and so this signal is impressed on the DC component just mentioned. Both therefore appear across the clock terminals.

As may be seen this simple arrangement for synchronising of the readout movement is achieved without interfering with the movement in any way. Two leads are

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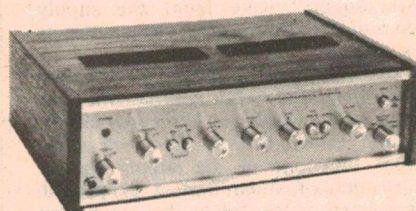
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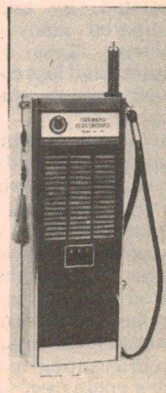
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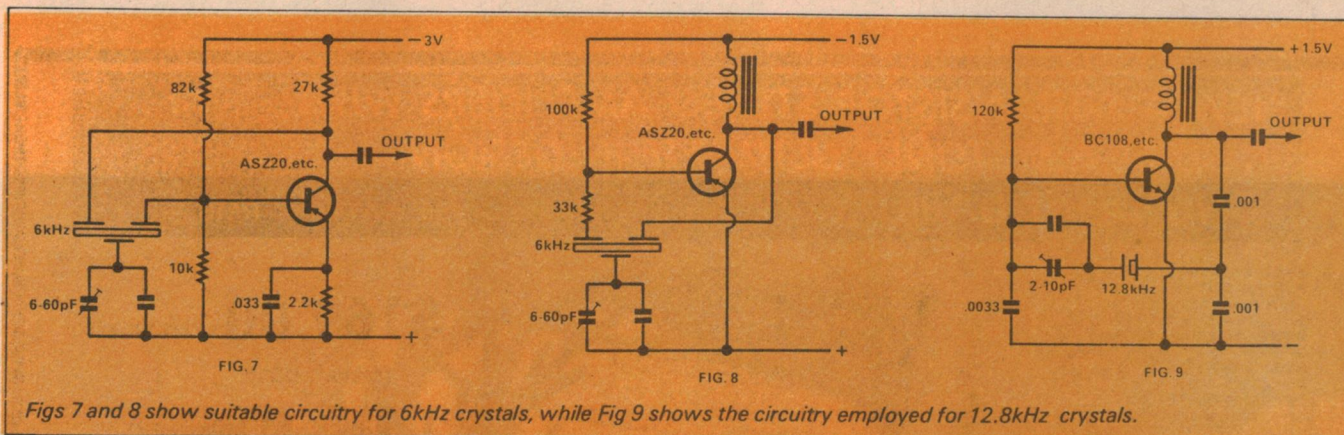
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FIGS 7 and 8 show suitable circuitry for 6kHz crystals, while FIG 9 shows the circuitry employed for 12.8kHz crystals.

merely connected to the lugs intended for the single dry cell. This is shown in Fig 1.

With only a 1.5V supply, the theoretical voltage drop of 1.2V across the transistors in Fig 1 would leave only 0.3V with a new dry cell. For the 1.5V version this problem is solved by introducing a transformer of about 1:1 ratio and parallel feeding the DC and signal components; a system of modulation, if you like. This is shown in Fig 2.

With the quite low frequencies likely to be involved in this circuit, the demand on a small transformer to pass say, a 25Hz square wave, is asking a lot of it. A small transistor audio driver transformer was tried, and although the frequency response as checked on a CRO was anything but good, it functioned very well.

We will leave the subject of dividers for the moment and look at crystal oscillators suitable for this particular application. As the subject is rather a vast one, we cannot hope to cover it in great detail but will touch on points which are likely to be of most interest to readers.

Possibly the most economical crystal frequency to use would be 1MHz. This frequency is getting into the lower price bracket. To offset this somewhat, more dividers are needed, with consequent expenditure in terms of money, space and battery consumption. Another theoretical advantage with the 1MHz crystal is that they are usually supplied in the "AT" cut, which, under its best conditions, has a very low temperature coefficient. A suitable circuit for 1MHz crystals for our purpose is shown in Fig 3.

The frequency which I am inclined to favour is 100kHz. The advantages are that less divisions are required, resulting in a saving of battery consumption, and there are no doubt many readers who have a crystal on this frequency salted away in the junk box. If one has to buy a new one outright, then the price may be somewhat more than that for 1MHz. However, this should not be excessive. The temperature coefficient is not as good as 100kHz crystals are normally ground from a "DT" cut or "+5degX" cut.

At a glance, both temperature characteristic curves look much the same. However, the DT cut usually has a lower temperature coefficient and it is possible to grind a specific crystal with a certain turnover point (within a tolerance of about plus and minus 10degC). The +5degX cut generally has a higher temperature coefficient and the turnover point is fixed at about 45degC. No doubt, economics will play an important part when ordering the

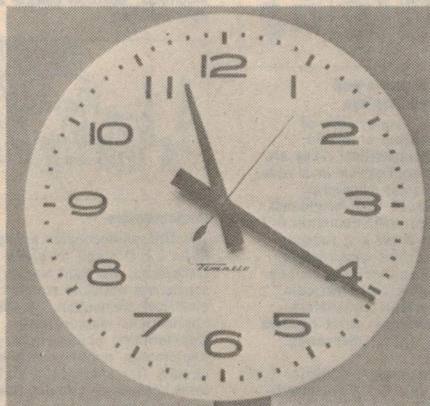
crystal of your choice.

Two simple circuits for 100kHz crystals and suited to our purpose are shown in Figs 4 and 5, as implemented for 3V and 1.5V respectively. However, we have a preference for the somewhat more elaborate circuit shown in Fig 6.

As mentioned earlier, I have carried out a large proportion of my investigations using 6kHz "NT" cut crystals. These crystals are in the form of a quartz bar, mounted in an evacuated glass envelope and fitted with a standard B7G type of valve base. Those which I have are four-terminal devices, although I understand that some low frequency crystals are also available as two-terminal devices. This is a minor point and can be readily accommodated with modifications to the circuit. Low frequency crystals are delicate devices and care must be taken in physically handling them. More importantly, they should only be used in a circuit which is not likely to shatter them.

Due to their delicate nature they should only be used in circuits as recommended by the manufacturers. We have used the 6kHz crystals mentioned earlier in the circuit shown in Fig. 7, when operating from a 3V supply.

Very low frequency crystals can be made to operate satisfactorily from a 1.5V supply but rather more has to be done to meet this requirement. The oscillator of Fig 7, if modified as shown in Fig 8, will perform well with 6kHz crystals. It may be seen that the resistive collector load has been replaced with an iron cored inductor. The optimum value of inductance has not been determined but something around 1 to 2H appears to be all right. The higher the inductance, the greater is the output, within



This Veddette unit from Timatic, as supplied by Australian Time Equipment, is typical of the movements suitable for crystal control.

limits. Under these circuit conditions, it is wise to insert a 33k resistor in series with the crystal, to avoid overdriving, with possible damage to the crystal.

Readers who are interested in this circuit could easily do some investigations on the best type of inductor to use. The current requirement is so low as to be negligible. Therefore, a small iron cored inductor, with many turns of fine wire, is indicated. Short of this, we have found one winding of a valve output speaker transformer to do the job. Filter chokes, transistor driver transformers, etc are some others which can often be used. The objection to most of these is the rather large size, but this may not always be a problem.

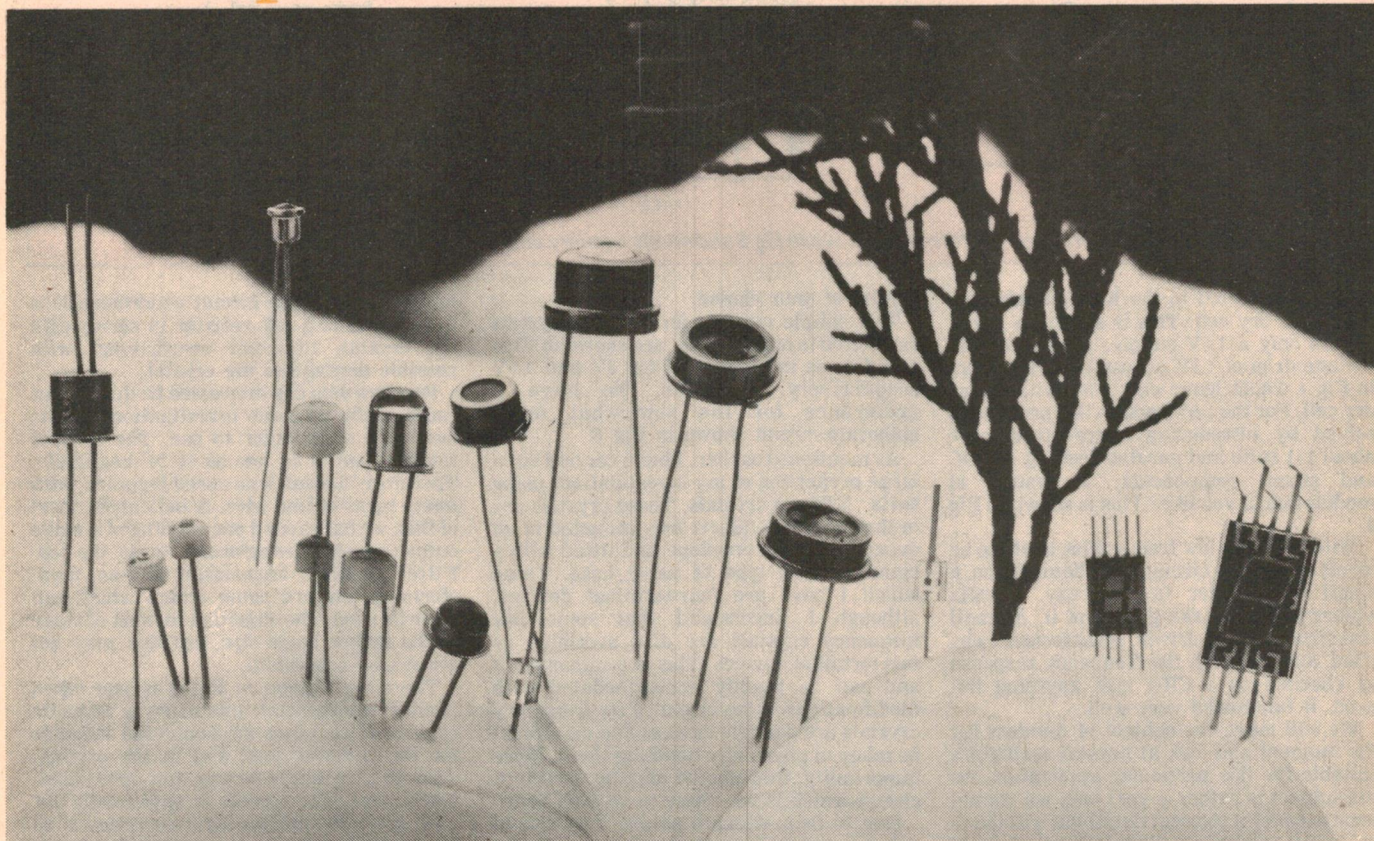
The circuit given in Fig 9 is one taken from a commercial unit using a 12,800Hz crystal. It also uses an iron cored inductor for the collector load and in the original units is a specially wound and very small component. The circuit is specifically for 1.5V operation and we have not tried it on 3V. Readers wishing to operate the circuit from 3V would be advised to guard against possible damage to a valuable crystal.

As you may well imagine, very low frequency crystals are rather expensive. The kind of price to be expected is about \$25 each plus sales tax. However, as a measure of compensation for the price, the frequency division is considerably reduced, offering the advantages of less cost for this part, lower battery consumption and slightly improved reliability. The temperature characteristic is rather similar to that for 100kHz crystals.

So far, we have only mentioned crystal frequencies in well rounded figures. They may well be suited to division down to say, 50Hz, 25Hz, etc. However, if you wish to avoid dividing by odd factors involving synchronised astable multivibrators, and wish to use only synchronised bistable devices dividing by two, then the crystal frequency required is most likely to be a rather odd figure. This should present no problem, assuming that you intend to have a crystal ground to order. Suitable frequencies just above or below 100kHz, or at a low frequency of say, 6400Hz may be obtained quite readily.

The subject of division has only been touched on so far. We have used both astable and bistable multivibrators quite successfully. For readers not very familiar with the use of these circuits for frequency division, it is worth noting that there are some important differences between them. The bistable multivibrator in ordinary circumstances, will divide only by two, or not function at all. This feature makes this

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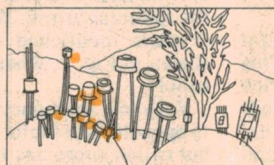


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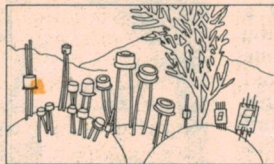
Typical applications include computer terminals, electronic desk and portable calculators, cameras, electronic wrist watches and various digital measuring instruments.

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(*not illustrated)
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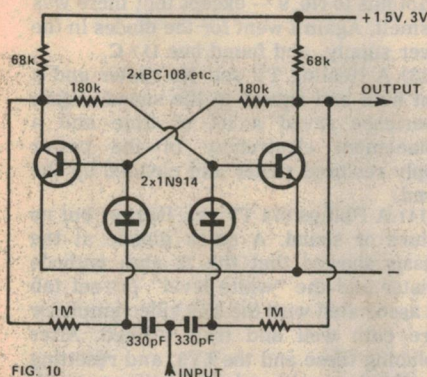


FIG. 10

type of divider a very reliable device. On the other hand, as it will only divide by two, quite a large number of dividers are normally required to divide down from a high frequency.

The astable multivibrator is rather different from the bistable circuit in terms of its behaviour as a divider. The astable circuit can be made to divide by any integer, from two upwards. We have had them dividing by as much as a factor of 20. But division with astable multivibrators is not completely reliable as in the case of the bistable circuit. Because the astable circuit can be made to divide by any number, in some circumstances, it is possible for the dividing factor to jump to the adjacent number either above or below the chosen one.

This problem can be almost eliminated by careful design and adjustment, and avoiding divisions above five or so, at least no greater than ten. The lower the dividing factor, the greater the percentage of change required to jump to the next adjacent number. Assuming these precautions, we have found it expedient to use a combination of astable and bistable multivibrators for our dividing circuits.

The principle which we have adopted is to use bistable divisions by two wherever possible and then use the astable circuit to divide by three, four, or five. To divide by ten, we use the factors two and five — ie, one bistable and one astable.

The basic circuit of the bistable divider used is shown in Fig 10. It must be pointed out that the circuit as shown is only suitable for dividing from frequencies around 2kHz or even lower. When dividing from higher frequencies, the two 180k resistors should be shunted with small capacitors, 220pF or less, as the frequency increases. Also, the 68K and 1M resistors have to be reduced in value as the frequency of operation is increased.

The basic circuit for the astable multivibrators used is shown in Fig 11. Values for capacitors are not shown, as these will depend upon the frequency and general operating conditions. The two time constant capacitors should be of equal value to suit the frequency, while the input coupling capacitor value will be determined by the amount of drive required, to lock the circuit to the required frequency. One or both of the 100k resistors may be varied to adjust the circuit to the wanted operating frequency.

The dividers, both astable and bistable,

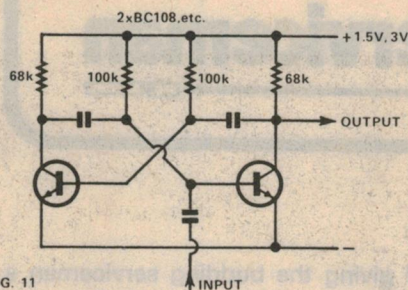


FIG. 11

Basic circuitry for the bistable and astable dividers is shown in Figs 10 and 11 respectively.

should function satisfactorily from 3V or 1.5V, with little if any changes from those given in Figs 10 and 11 apart from those required for operation at different frequencies.

From the information given thus far, the experienced reader should be able to tailor his own clock system. By way of an example, suppose that a 100kHz crystal is to be used with a readout movement of the transistor switched variety, and with the usual 5 beats per second. The drive frequency for this type of movement may be 25Hz, as discussed earlier, and this will require a division of 4,000. This may be achieved with five binary dividers, together with three astable type dividers each dividing by 5.

In addition, a suitable oscillator circuit may be chosen from Figs 4, 5 and 6. At the other end, a driver circuit from either Fig 1 or 2 will be needed and the type will depend upon the supply voltage chosen.

Even after having decided upon the design and having made it up, there are a number of points which can help in getting the unit functioning properly. This sort of discussion is outside the scope of this present article, but in the unit which we hope to describe very soon, these points will be covered.

Some readers may be asking the question as to why we have used discrete components throughout, rather than go to the use of ICs. The answer is a simple one in that, as far as we know, there are no suitable ICs on the market which will suit our purpose. Many commercially available crystal clocks now use the IC technique, with a consequent major saving of space, but they are almost certain to be custom-made types and not available to home builders.

Philips Elcoma have produced a very attractive IC specifically for a battery operated crystal clock. It is intended to operate with a 32,768Hz crystal and when divided by 2 to the power of 15, gives an output of one second pulses. It will operate over a supply range of 0.9 to 3 volts and the typical current consumption is 24uA. The type Nos are SAJ250A and B, according to the package and other minor details.

This IC has been investigated but the main problem lies in the apparent lack of a suitable movement to use in conjunction with it. Of course, a special crystal on 32,768Hz must be used, but these are obtainable. The only devices which will respond to one second pulses, are units

which are quite specialised and consume somewhat more current than would be permissible for strictly battery operation. Philips suggest the use of a stepping motor but this falls into the same current category.

The idea of increasing the crystal frequency by a factor of five, resulting in an output of 5Hz pulses seemed to be worth investigating. Unfortunately, the investigations I was able to make along these lines proved to be unsuccessful. In spite of this, some readers may be interested in this IC and may be able to accommodate the problems associated with the higher current consumption. Further inquiries may be directed to Elcoma but we understand that stocks were not readily available a short time ago at least.

Another question which readers may be asking, is what sort of time-keeping can be expected from the type of clock under discussion. This is not an easy one to answer, as this factor is very much tied up with the crystal oscillator and more particularly with the characteristics of the crystal being used. As I see it, the main problem lies with the temperature versus frequency characteristics of the crystal which you are using and this may vary over quite a wide range.

A study of crystal manufacturers' curves and figures would indicate that if the oscillator is adjusted precisely for the average ambient temperature, a sharp change in temperature could easily cause a change in time-keeping by about one second per day. This is still well within the needs and requirements of many users and would be acceptable for many navigational purposes.

A further question arises from this latter discussion. Is it possible to have a battery operated crystal clock and provide some form of temperature compensation to improve its time-keeping qualities? Before we answer this one, it is worth bearing in mind that the results obtainable from an uncompensated crystal clock are so superior to other types of clock systems that in most cases an improvement will not be sought. Work is proceeding however on this aspect of crystal clocks and although I am not able to make any definite statement at the time of writing, suffice to say that the indications are encouraging.

Another point of interest is that during the past few weeks, the new developments which have come forward are quite exciting. Apart from the work on temperature compensation, I have succeeded in synchronising the newer type of tuning fork battery operated clock. This can have some advantages over the system just described, in that the fork operates at a higher frequency, 100Hz, 300Hz, to quote two of them, with consequent less division. It should also make for a more reliable unit under portable conditions, a point raised earlier. Also, the second hand runs smoothly, rather than jumping at a rate of five per second, which has some aesthetic appeal.

Work is already proceeding on a clock which is at least partly temperature compensated and one which uses a tuning fork movement for the readout. It is hoped to describe such a clock in the future, providing a satisfactory design can be achieved. However we would like to emphasise that such a unit would not render obsolete the one which we propose to describe shortly.



The Serviceman

Typical routine jobs

One risk in writing these notes is that of giving the budding serviceman a wrong impression: that servicing is all intermittent faults and similar curly problems. It isn't. You'll get your share, of course, but the great bulk of the jobs will be routine and — let's face it — relatively dull.

As I have mentioned on previous occasions, the kind of service job I usually write about is not the kind of job that pays the shop rent. More often than not one is battling to keep the bill down to a reasonable figure and still break even on the deal.

And since we cannot pick and choose our jobs, what we loose on the swings we have to make up on the roundabouts; in this case the routine jobs that seldom find their way into print.

Several months ago, a colleague employed in one of our larger service companies contributed his experiences of service calls over a period of several days on the road. Although most of these were routine, they nevertheless created a lot of interest. This was mentioned to me by another colleague the other day, when he enquired about the possibility of a similar article appearing again.

"Well, what about you?" I said.

"Yes, I'll be in it," he replied.

So, for the next few days, he took a pad and pen with him on his rounds, and came up with the following.

(1) An Astor TV set. The customer complained that the picture had dropped to a height of about two inches. A new 6GV8 valve restored the height to normal, and the job was done.

(2) An HMV V1 TV set. This set had a raster but no picture or sound. I hinged the chassis down, checked voltages and found no HT on the video IF stages. As I had a raster, I knew that the main HT was present, thus ruling out the transformer, rectifiers, etc. I checked the 300 ohm 5 watt decoupling resistor which feeds HT to the video IF, and found it O/C. Replacing this restored the set to normal operation. Just why the resistor failed, I don't know. I checked the set's performance and found all voltages, etc., to be normal. However I have found these resistors open in the past without any apparent reason.

(3) An Astor TV set. This one had horizontal pulling — particularly on heavy contrast. Experience has taught me that an open power supply filter capacitor would be the most likely offender. A new 100 +200uF electro cured the trouble.

(4) A Philips 1100 series TV set. Poor contrast. Replacing the 6U9 brought contrast back to normal. Another happy customer.

(5) A Philips tape recorder. My next call was to a tape recorder in one of our local government institutions. The recorder would only record sometimes, but more often would not. It played back OK. I removed the covers and sprayed the contacts of the various push buttons with "Serviceman's Friend" and manipulated them several times, after which the machine recorded each time. A phone call a week later confirmed that the recorder was still working OK.

(6) A Sanyo record player. This also involved a cleaning job — the turntable would not rotate. I removed the turntable and found that the motor spindle was stiff to turn with the fingers. A squirt of "Serviceman's Friend" on the bearing and the motor was again running perfectly.

(7) An Astor TV set. Picture pulling on heavy contrast. Again I replaced an electro in the power supply and another cranky set was back in business.

(8) An AWA tape recorder. The customer stated that it would not record and was very weak on playback. He explained that it was used a lot at parties, and as the family were going to another one that night he would like it fixed — if possible. A quick look at the heads and rollers soon showed why it wouldn't record or play back satisfactorily. A good clean up with a soft rag moistened with methylated spirit and the recorder was again working normally.

(9) A Pye I26 solid state TV set. Complaint — wedges in picture — hum in sound. Sounded like an electrolytic — but it wasn't. In fact when I removed the cover, I was greeted by the tell-tale smell of something cooking. A quick check with the multimeter showed one of the power diodes in the bridge rectifier was shorted, and another open. To be certain, I replaced all four. The set then worked perfectly. A phone call to the customer a week later confirmed that it was still OK.

(10) A Healing TV set. Picture took about five minutes to come on — and then was narrow. A new 6CM5 cured the trouble.

(11) The same customer had a portable radio (HMV Sprite) which lost sound intermittently. As the fault was frequent in repetition, and particularly at low volume, I took a punt on the speaker — and sure enough it was. When the set cut out, I could restore it to normal by pressing lightly on the speaker cone. Not having a suitable

speaker with me, I took the set back to the workshop, and fitted a new speaker.

(12) Another 12 inch solid state portable TV set — HMV Z2 this time — with similar symptoms to No. 9 — except that there was no smell. Again I went for the diodes in the power supply, and found one O/C.

(13) A Healing TV set. No raster and a faint hum and squeal in the sound. Again experience saved a lot of time and a replacement electrolytic in the power supply restored raster and cleaned up the sound.

(14) A Philips 074 TV set. Raster, but no picture or sound. A quick glance at the chassis showed that the 22 ohm cathode resistor and the "white level" pre-set tab pot associated with the 6Y9 video amplifier were both well and truly cooked. After replacing these and the 6Y9, and resetting the 6Y9 plate voltage to 70V without signal, the set returned to normal. What happens is that the 6Y9 apparently shorts intermittently, and takes the other two components with it. Before leaving the set, I fitted a modification suggested by the manufacturer to minimise this trouble. This consists of a 1500 ohm 5 watt resistor in series with the screen (pin 9) of the video amp. section of the 6Y9. Should the tube flash over again or short, this resistor limits the current which can pass through the cathode resistor, and thus prevent the other components from burning out.

(15) A Philips 1100 series TV set. An easy one. No raster. 6CM5 not alight and white around the top cap. I carefully removed it and fitted a new one. Another one working.

(16) HMV V1 TV set. Raster but no picture or sound. Replaced 6Y9 and produced a weak picture and quite good sound. Replaced 6X9 — good picture and sound. Adjusted the contrast range preset, and the job was done.

(17) Kriesler TV set. Another easy one — no raster. Replaced the 6AL3 and moved on to the next job.

(18) A Healing 800 series TV set. A dim, narrow raster — this was the owner's description. On examining the raster more closely, it appeared to have a trapezoidal effect. This is usually caused by a faulty yoke. When I looked at the yoke I could see why. It had almost decomposed, the epoxy base had just about disintegrated with either excessive heat, old age or both. As I did not have a suitable yoke with me, I had to call back later that afternoon. Fitting a new yoke restored the set to normal.

(19) The same owner asked me to look at an old mantel set (HMV) which squealed whenever it was tuned. Fitting a new 6BA6 cured it, although it still had an intermittent rushing noise. Replacing the 6BE6 cured this fault and the old set gave a very good performance.

(20) A Kriesler TV set — 79-23 chassis. Raster took about three minutes to appear, and when it did, the horizontal hold control required frequent resetting for the following few minutes. Again experience shortened the task, and a new 6X9 horizontal oscillator valve fixed it. I also replaced the 6U9 and the 6X9 in the video IF stage, as these were weak also, causing poor contrast.

Well, that's my friend's list, and it is about as representative of routine day to day jobs as one could get. Note that most of the jobs were completed on the spot, and

that many look only a few minutes.

Note also how often he used the phrase "previous experience". If you are a budding serviceman, take particular note, for experience is the name of the game. The service manual, the text book, and the slide rule are fine when you're stuck with a curly one — but curly ones don't make money.

Finally from a serviceman apprentice in Victoria comes a letter expressing his appreciation of these notes, and relating how a story from several years ago helped him in a recent unusual job.

The issue which prompts this letter is October 1964. And what connection has this 10-year-old issue with this letter, you may well be asking.

In this article the serviceman mentioned some baffling results he had when he replaced a known faulty 6M5 valve with a brand new one and found that it, too, refused to work.

The solution was that the set was wired with the cathode bypass capacitor connected to pin 3, the true cathode, and the cathode resistor to pin 8, marked N/C but in the valve actually in the set connected internally to pin 3.

With a current series 6M5 the set did not work, due to the valve design being slightly modified and the internal connection being deleted.

Such was the set which I encountered this very week. The set had been brought in minus the cabinet and speaker by the handyman owner and sported a brand new 6M5. I immediately tried another new 6M5 on the theory that the other might have been a faulty new one, something which has happened in the past, but this one, too, refused to work. So I upturned the chassis, commenced measuring voltages, and encountered the puzzling wiring described earlier. There was no sign that a resistor had ever been connected to pin 3 and so I consulted the valve manual to make absolutely sure that the cathode was pin 3.

... Then from within the dim recesses of my mind came this story and I immediately checked pin 8 and found a resistor attached to it. So I shorted pin 3 and 8 together with two screwdrivers and the set burst into life. I lifted the resistor from pin 8, transferred it to pin 3, and the set worked like the proverbial "beaut".

But think how puzzled I would have been if I had not remembered the article.

The owner was hopping mad when he heard the story. While cleaning the dust and fluff out of the back of the set he had been unfortunate to bend the 6M5 in its socket, thus twisting the pins. He used a pair of pliers to straighten them but broke the glass and the valve went gassy. Then he bought a new 6M5 which, being made differently, refused to work.

Another common fault I have found (also mentioned in an old Serviceman article) and which again concerns the 6M5 is silver migration between pins 1 and 2. This fault is all but dead now but still crops up in some of the very early Kriesler sets and some old radiograms still fitted with their original 6M5. My usual cure is to turf the old valve out and fit a new one, since they are at least ten years old anyway and about due for replacement.

Yours faithfully,

R.M., St Albans, Vic.

Well, thank you, R.M., and it is gratifying to know that these stories help readers, even after many years.

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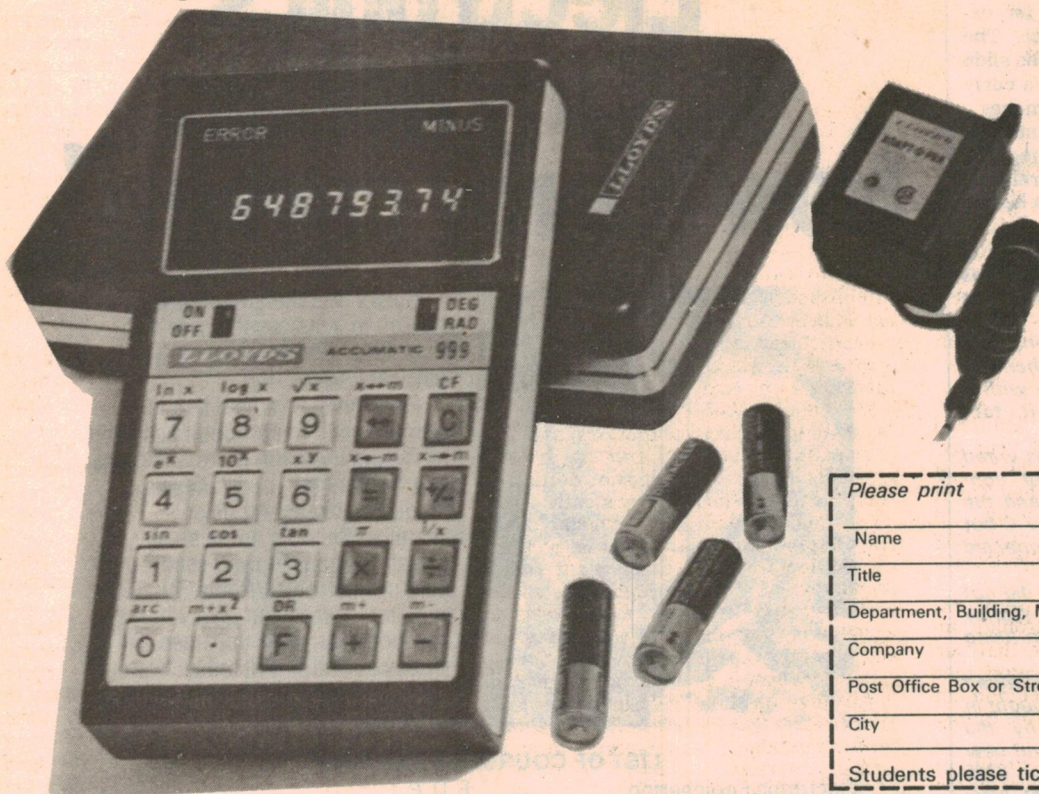
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keys to perform other memory functions

▲ EIGHT-DIGIT DIGITRON® DISPLAY

A brilliant 8-digit Digitron display is located at the

top of the calculator. This patented display is actually brighter and superior in legibility to the light emitting diodes (LED's) found on many other calculators. The display also

contains an overflow (error) indicator as well as a negative number (minus) indicator. The wrap-around decimal feature enables calculations to proceed even when answers exceed 8-digits.

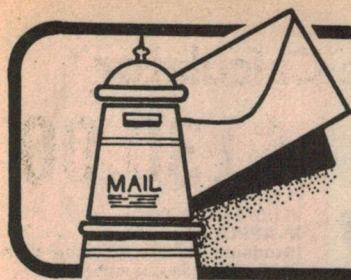
▲ OTHER SPECIAL FUNCTIONS

Other important function keys on the Accumatic 999 include: Pi (π) key; a multi-purpose Clear (C) key; Data Recovery (DR) key; and Change Sign ($+/-$) key. And in addition to performing basic geometric, trigonometric and logarithmic functions, the Accumatic 999 is capable of executing certain other advanced operations, including quadratic equations, hyperbolic and inverse hyperbolic functions, and polar to rectangular transformations. In the field of business and finance, the Accumatic 999 can compute: compound interest, present value, and mortgage amortization. In statistics: mean and standard deviation and chi squared evaluation. In electronics: charge on a capacitor and admittance problems. There's no end to the Accumatic 999's versatility!

▲ AC/DC OPERATION The Accumatic 999 operates off 4 long-life alkaline rechargeable batteries. And a combination AC adapter and battery charger lets you save the batteries and run the instrument off 120 volt AC house current when you're near an outlet. AC adapter/charger and batteries are included with the unit.

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Reciprocal ($1/x$)	YES	NO	YES	YES
Square Root (\sqrt{x})	YES	YES	YES	YES
Change Sign ($+/-$)	YES	NO	YES	YES
Add (+)	YES	NO	YES	YES
Subtract (-)	YES	NO	YES	YES
Scientific ($X10^{xx}$)	YES	NO	YES	NO
Notation				
No. of Digits	8	3	10	8
Readable				
Pi (π)	NO	YES	YES	YES
Exponent (x^y)	NO	NO	YES	YES
Natural ($\ln x$)	NO	YES	YES	YES
Logarithm				
Natural (e^x)	NO	YES	YES	YES
Antilogarithm				
Common ($\log x$)	NO	YES	YES	YES
Logarithm				
Common (10^x)	NO	YES	NO	YES
Antilogarithm				
Trig. Functions	NO	YES	YES	YES
Memory	NO	NO	1+Stack	1+x→m 2 x→m
Radians/Degrees	NO	NO	NO	YES
Display Recall	NO	NO	NO	YES



Letters to the editor

The views expressed by correspondents are their own and are not necessarily endorsed by the editorial staff of "Electronics Australia". The Editor reserves the right to select letters on the basis of their potential interest to readers and to abbreviate their contents where this appears to be appropriate.

Australian industry

May I compliment you on your "Editorial Viewpoint" in the June issue of your excellent journal. It painted a clear picture of the effects so far of the November Tariff decision and nobody could argue that, in general, your estimate of the impending problems of the Australian Electronics Industry is correct.

When every other country in the world protects and fosters its electronics industry, it is almost unbelievable that our Government could take such action that leaves the Australian electronic equipment and component manufacturers at the mercy of imports.

In the Tariff decision there was no built in automatic adjustment of Tariffs to cater for rapidly rising costs of labour and materials; no attempt to restrict the level of imports from countries with a low standard of living and where employees are paid little more than subsistence wages; not even any incentive to the Australian industry to produced finished equipment in Australia from the low priced imported components — because the same duty rate applies to both. In fact, the proclaimed objective was to provide cheap imported Radios and Mono TV now and, more particularly, low priced Colour TV in due course.

It is apparently a case of "Oh well! We have full employment and anybody put out of work in the electronics industry can go and get a job somewhere else."

That may be true, but what happens to the technical skills that have taken years to develop? The special technologies involved in the electronics industry cannot be relearned overnight. Once the various segments are shattered and scattered, it will take many years to restore them. And restore them we must if Australia is to grow as an independent nation.

Having said all that in support of your editorial, I must now say that we believe the Australian electronics industry will survive. In spite of the great difficulties which at present loom ahead, it will continue to give Australian Engineers and Technicians the opportunity of showing they are the equal of or better than any in the world; to develop advanced technologies in spite of the immediate small demand; to provide quality componentry and equipment at reasonable prices consistent with the high standard of living enjoyed by the average Australian.

In your editorial you have made the statement "there is now virtually no resistor or capacitor manufacturer in Australia".

Perhaps the word "virtually" lets you off the hook, but the fact is that IRH Components (formerly International Resistance Company (Australasia) Pty. Limited) was established over 40 years ago, is fighting fit, and is here to stay. We are still the largest manufacturer of resistive products in the Southern Hemisphere, and proud to be an Australian Company.

We believe there is a future for the Australian Electronics Industry and have demonstrated our confidence by investing several hundred thousand dollars in equipment over the past few months to give us a modern thick film "metal glaze" resistor production plant. That is, of course, in addition to our existing plant for the production of fixed deposited carbon, carbon composition, wire wound resistors, variable carbon and wire wound resistors and ceramic capacitors.

In future issues of Electronics Australia, it will give us great pleasure to prove to your readers that there is definitely a major resistive products manufacturer alive and well in Australia.

Lloyd H. McCulloch,
Sales Manager, IRH Components Division,
Natronics Pty Ltd,
The Crescent, Kingsgrove NSW.

Metric dimensions

I have been a regular reader of your publication since before the "Radio and Hobbies" days, a fact which in itself is my recommendation of its value as a popular publication.

I notice it is becoming the practice to quote dimensions of products and projects in metric units. However I view with concern the use of "centimetres" in E-A, not millimetres or metres. The May issue quoted the size of a ferrite rod and a circuit board in centimetres, and although the advertiser of the calculator offered to readers in the June issue gave its size in millimetres, your accompanying article used centimetres.

The conversion to metric is going to be difficult enough without the use of unofficial or non-standard units. It is hoped your editorial policy with regard to the use of metric units will be as precise as it was with the use of Hertz to replace cycles per second, a few years ago.

R. N. Simpson,
(West Pennant Hills, NSW).

COMMENT: While we value your opinion, we find it hard to become as worried as you appear to be. Despite the fact that the Metric Conversion Board has decided to frown on the centimetre, our observation among our own staff and elsewhere is that people are continuing to use the unit. We suspect that this is because it represents a size which is more convenient, for many purposes, and more readily visualised than either the metre or the millimetre. One way or another, we think it likely that the unit will continue to be used. Surely the real test of a unit is that it meets the needs of people

in measuring, not that it has bureaucratic approval.

Transistors — when?

I am writing this letter in the hope you or a reader may be able to enlighten me on an interesting anomaly I have come across. I feel it a very interesting matter. In all the literature I have ever read, the date for the discovery of the transistor is given as 1948, it still only being a lab. curiosity.

Yet in two books I have read recently I came across reference to the use of transistors as early as 1941. The first book 'A strange Kind of War' by Admiral M. Miles, says that in 1941 he received some 'transistors' from Bell Labs. for him to evaluate in his capacity in a sort of inspection and evaluation of new inventions.

The second reference occurred in 'Day of Trinity' by Lansing Lamont where among other things he mentions that some transistors arrived. This was 1945.

I would be very pleased to hear any information anyone may have on this matter as it seems strange to hush up a 7 year discrepancy this many years ago.

Russel Costin,
(48 Real Avenue, Norman Park, Qld 4170).

COMMENT: It is perhaps possible that the discovery was made as early as 1941, and was hushed up for political reasons. But if this were so, there would be little reason nowadays to perpetuate the story. We are more inclined to think that the authors to which you refer got their dates a little mixed — something which happens very often and makes all historical records open to question to some extent. Some of the readers may have further information for you, however, and we have published your full name and address so that they can contact you direct.

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Three channel stereo mixer

Elementary
Electronics



For a change, this month, we are presenting a contributed article. It describes a three channel stereo mixer which should appeal to many readers by reason of both its simplicity and its low cost. It should also provide an interesting constructional exercise for the beginner.

by BRIAN WOODWARD*

Mixer circuits appearing in the last few years have, generally, been complex, filling the requirements of pop-groups using very elaborate recording equipment. The cost of building a mixer using complex matching techniques is high in relation to the use such a mixer would have if it is being used only with domestic equipment; record players and cassette recorders.

The author's requirements were simple; a low-cost, stereo mixer capable of handling three channels, with matching facilities for most portable equipment. It was to provide music and spoken accompaniment to a slide show, with the third channel to add a tone signal for the projectionist, indicating a

change of slide. This was overcome by adding a 22k resistor in series with the potentiometer wiper but introduced the second problem — significant signal loss. This was overcome by adding a very basic amplifier with a gain of about 20.

The amplifier uses the new edition of the BC109, the plastic encapsulated BC549 which is presently available for as little as 25 cents. Whilst the circuit is not "hi-fi" the amount of distortion added is minimal and is unlikely to be greater than the inherent distortion in most cassette recorders.

The output could be taken directly from the 4 uF capacitor at the collector but, in the prototype, a 10k output level control was

added to function as a master control and give increased versatility to the unit.

There are three chassis on the prototype; one each for the input sockets, the circuit board, and the output sockets. These were made from scrap aluminium, although the entire unit could be mounted in an aluminium box. But if the layout for the circuit board illustrated is used, the measurements given, particularly those for the potentiometer shafts, must be strictly adhered to.

Cut and drill the chassis as indicated, drilling small pilot holes before drilling the 6mm (1/4in) holes for the shafts. Score the line where the chassis is to be folded several times with a tungsten carbide tipped marking pen or a sharp awl, then fold the chassis. When shaping the chassis fold a section through only a very small angle at any one time as aluminium stretches very easily and may become distorted.

Before drilling the circuit board mark the holes that are used by the trimpots and drill a slightly larger hole. The correct size is 1mm. Although a one-off circuit board was made for the prototype, Veroboard is also suitable as the hole size is usually correct for trimpots. If using Veroboard construct the mixer with the copper strips running in



The original unit was housed in a small wooden box but the final choice is a matter for the individual. The master volume control knob is on the left and the mixing knobs on the right marked "1", "2", and "3".

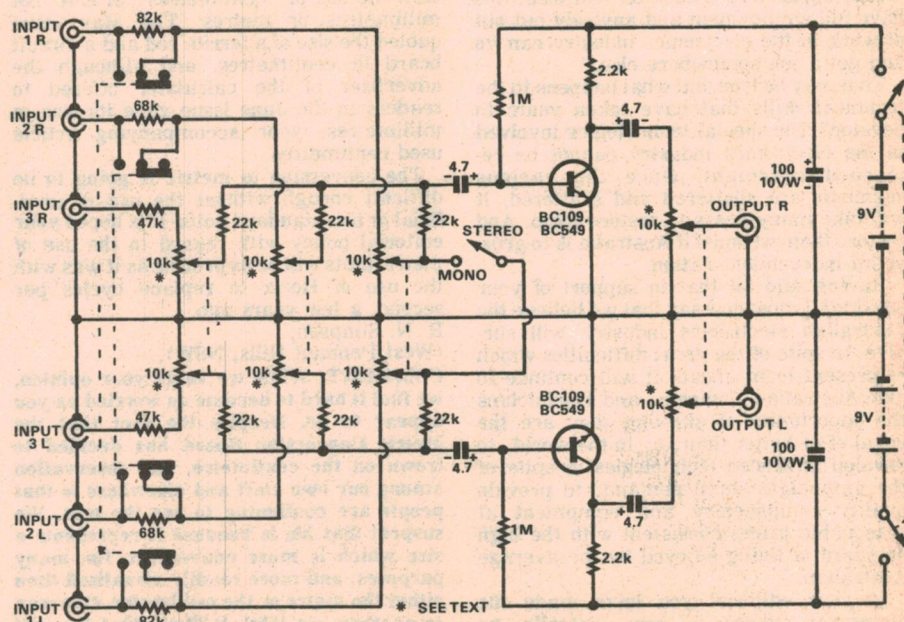
change of slide. For club use, or for sending slides and a cassette to relatives abroad, a mixer adds a touch of professionalism difficult to obtain by any other means.

Before construction began it became obvious that potentiometers were the largest single cost, followed closely by sockets and matching circuitry. An enormous saving was made with the former by using disposals trimpots joined by shafts made from No 4 knitting needles.

(Editorial Note: The use of trimpots in this role may not have the approval of the manufacturers. Trimpots are not necessarily designed to withstand the same number of operations as a conventional pot, and the constructor must be prepared to accept some risk of premature failure.)

Sockets were limited to RCA and 3.5mm jacks although DIN could also be added. Matching circuitry was limited to resistors switched in or out to give approximately the correct matching value.

It is possible to construct a passive mixer using potentiometers alone but two problems arise. Firstly, there is considerable interaction between the wipers of



*8 / 39 Walton Crescent, Abbotsford, Victoria 2046.

The circuit is comparatively simple, consisting of three passive mixers for each channel, followed by an amplifier and a master volume control.

the same direction as the trimpot shafts and use links for the "earthy" side. This will greatly reduce the number of copper strips that have to be cut.

When assembling components, mount all of the trimpots first. Do not fold the mounting lugs on the copper side of the board but trim them very short so that they stand no more than 1mm above the copper. At a later stage the wiper arm has to be eased slightly away from the resistance strip and, if a wiper is moved too far and goes open circuit, the trimpot will have to be replaced. So it should be as easy as possible to remove from a completely assembled board.

After the circuit board has been assembled fit the input and output sockets and switches to their respective chassis and wire up the matching resistors. Connect the sockets to the board with the thinnest available shielded cable, and be aware that the cable must be long enough to rise above the shafts when assembled and also allow room to manoeuvre the small interconnecting shafts into place.

Temporarily fit the circuit board to the chassis to determine the correct length for the power supply leads and the mono/stereo switch leads. After these have been soldered into place, the mixer can be tested.

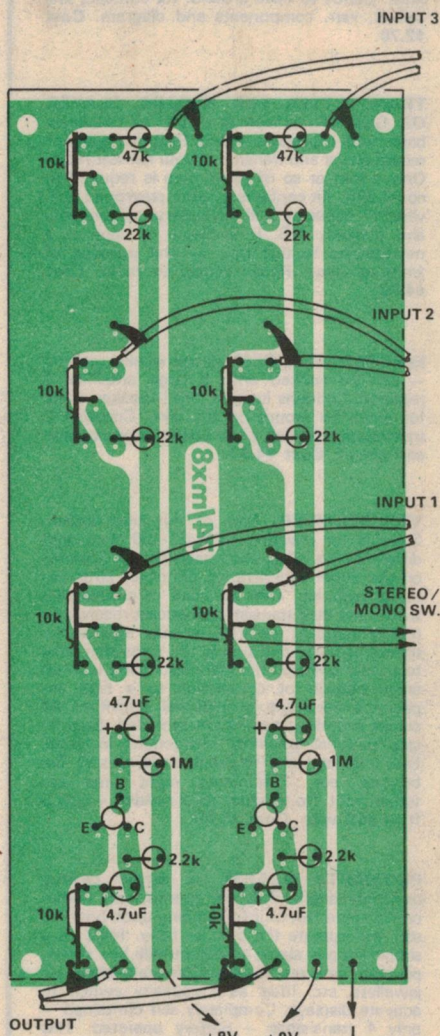
With a small screwdriver, set all the trimpots to mid-position. Connect the batteries, and connect the output to an amplifier. Inject a known mono signal into each of the inputs in turn to ensure that a variation in component values has not cut a signal excessively in any channel. Switch the matching resistors in and out of circuit during the test as they too should be balanced.

With the circuitry operating satisfactorily the board and switches can be mounted on the chassis. Connect an ohm meter to one side of a trimpot and to the wiper. Very gently prise the wiper away from the resistance strip taking great care not to damage the carbon surface. Continually check the operation of the trimpot with a small screwdriver until a noticeable lowering of the friction has taken place but the wiper has not open circuited. A proprietary potentiometer lubricating spray is also a great aid in easing the operation of the trimpots. It will also assist in preventing noise from the trimpots.

The trimpot shafts can now be made. Cut the knitting needles with a fine-toothed hacksaw to the overall lengths given in the

drawing, 20mm and 57mm, and mark the area to be trimmed with a pen, preferably a solvent based pen.

The length to be trimmed is 3mm on the short shaft and 7mm on the longer one. Clamp the end of the shaft that is not to be trimmed between two pieces of wood and cut the 1 x 2mm rectangular section with a metal file or with the flat face of a fine



Printed wiring board, viewed from the component side. Pattern is full size.

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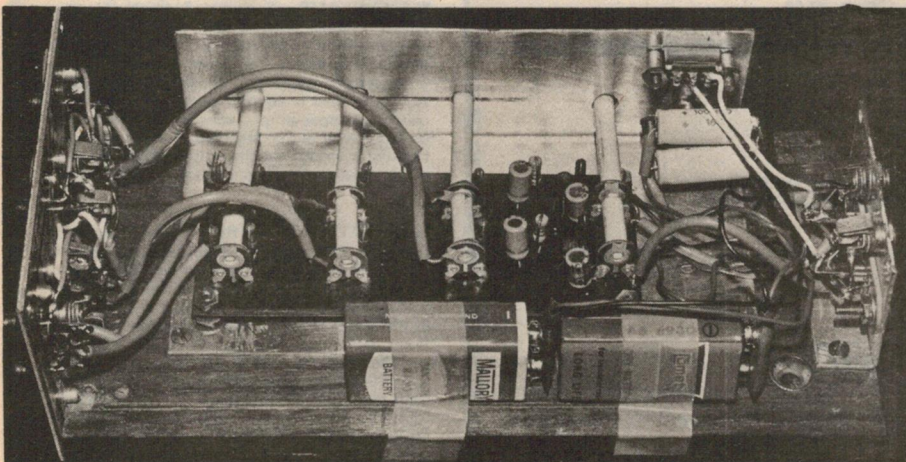
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Rear view of the complete unit. The input panel is on the left, the three mixing pots on the left of the board, and the amplifier and master control on the right.

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COMPRESSOR / PEAK LIMITER. A simple design which really works well. Runs off 6v DC or off your 6.3v AC heater chain. This kit includes a built in rectifier for operation off the heater chain. Ideal for your Ham rig, PA system, tape recorder, guitar amp (specially suited to bass guitar to give that rich 'chunky' sound). Incorporates fairly fast action and slow decay. Can be adjusted for peak limiting or compression. Can be fitted simply to any audio amp. Kit contains all the components plus circuit and explanation of function. **Cost \$6.40.**

CODE PRACTICE OSCILLATOR (earphone version). Simple compact little unit drives a magnetic earphone. Very pleasant tone. Kit contains earphone, transistor, all parts except morse key, and circuit. **Cost \$3.90.**

METAL LOCATOR. Detects metal to a depth of 18". Can be fed into a pair of headphones, either low or high impedance, or to a small amplifier. Full pictorial details for building the search coil. Also diagram for recommended layout. Gives rather outstanding performance for such a simple device. Entirely portable with a weight of only 2 lb. Great for finding metal objects under the sand at beaches. **Cost \$7.95.**

COLPITTS XTAL OSCILLATOR. For testing xtals. Handy to have around. Kit contains xtal socket, xstr, components and diagram. **Cost \$2.70.**

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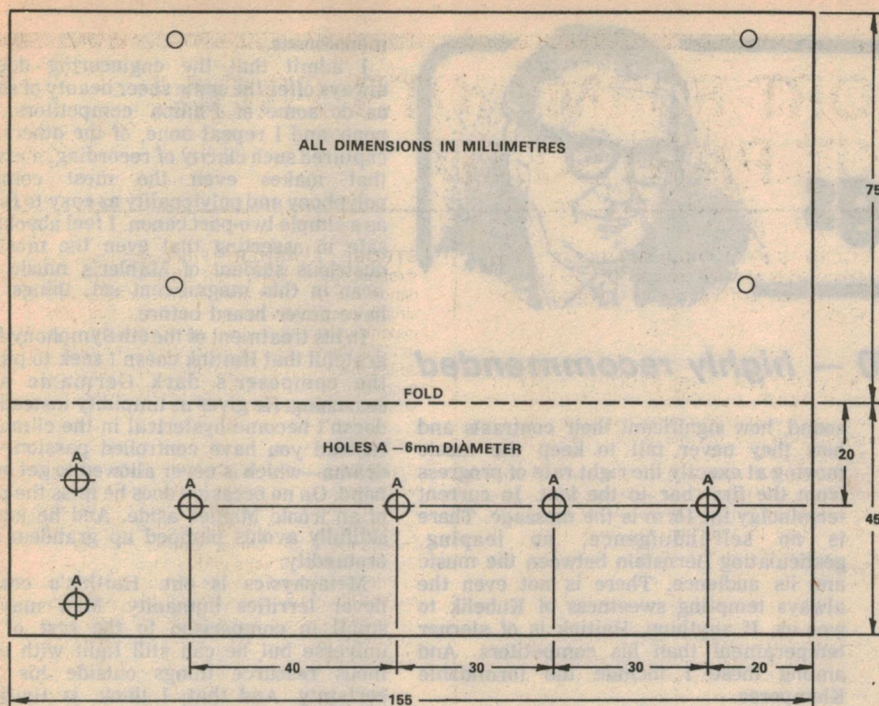
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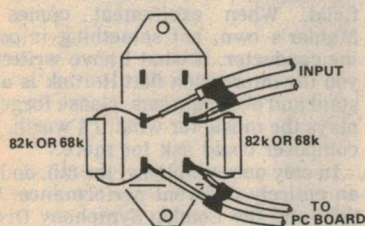
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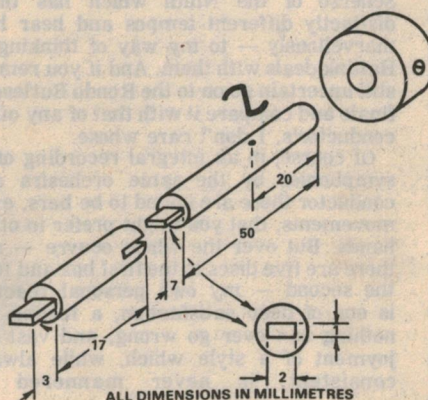


Wiring details of the impedance switch.

grinding wheel mounted in a power drill. Check the dimensions frequently when grinding.

Cut the slot in the end of the short shaft with a hacksaw blade which, conveniently, should give a cut 1mm wide. Make sure that the cut aligns with the flat section filed on the other end of the shaft. The accuracy of this cut determines the stereo balance of the mixer.

The shafts can now be fitted to the mixer. Place the front shaft through the chassis



Dimensions and details of the pot shafts.

hole and rest it in the slot of the front trimpot. The second shaft can now be fitted, preferably with both trimpots at minimum level setting, and held in place with tweezers as the front one is pushed in and slotted into the recess on the rear shaft. Slip a 10-15mm length of wire through the small hole drilled in the shaft to prevent it from being pulled out of the mixer.

After the operation of the shaft has been checked a small dab of fast-setting resin cement can be applied to the joint at the rear of the front trimpot. If the mixer is to receive a great deal of use, and after the operation of the mixer has again been checked, more glue can be applied to the shafts where they butt on to the trimpots. Take care not to allow glue on any moving surface.

Once completed the mixer will invariably find uses for itself. The author makes cassettes for parties or cars using two turntables. This eliminates the pause between tracks on a record and offers the possibility of some variation in music rather than twenty minutes of the one composer.

Although two batteries have been used, a battery drain rarely exceeds 2.5mA so their life should be quite long.

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Classical Recordings

Reviewed by Julian Russell



Mahler: Symphonies 5-10 — highly recommended

MAHLER — Symphony No. 5 in C Sharp Minor. Symphony No. 6 in A Minor. Symphony No. 7 in E Minor. Symphony No. 8 in E Flat, with Ileana Cotrubas, Heather Harper, Hanneke van Bork, Birgit Finnila, Marianne Oeleman, William Cochran, Hermann Prey, and Hans Sotin. Four choirs and organ. Symphony No. 9 in D. Symphony No. 10 (unfinished) in F Sharp. All played by the Concertgebouw Orchestra of Amsterdam conducted by Bernard Haitink. Philips Stereo No. 6761 001 (Ten discs in box.)

I recently wrote about a Philips box containing Mahler's first four symphonies played by Haitink and the Concertgebouw Orchestra and, in doing so, admitted that despite much formidable competition from other established Mahler interpreters Haitink was, to me, the most satisfying. Should you have missed that issue or skipped reading my review I will repeat here the salient points, the combination of which I find unique in Haitink's performances.

In the first place there is Haitink's unswerving concentration throughout any symphony he is playing. Despite the alluring byways scattered by the composer, Haitink always keeps to the main road, so to speak. He examines these byways, appreciates their charm, and often their beauty, but never blows them up into highways. His progress never deviates. Does this make his Mahler sound stark and totally lacking in irrelevant, if beautiful, asides? By no means. Haitink offers Mahler's music with all the many directions of the composer respectfully observed, though admittedly these often leave plenty of choice to the conductor.

In reviewing Philips' new box which contains Mahler's other six symphonies, including the unfinished 10th to save space I use Haitink's performance of the Ninth as fairly typical of the others. So that I can now add that if the conditions I set out above were all that is needed to bring off Haitink's great performance of the Ninth, even a concertmaster by slavishly observing the same markings could produce something just as great.

Nothing could be further from the truth. In addition to noting Mahler's smallest guide, Haitink shows that he appreciates just why the composer put it there. This understanding results in the succession of profound truths that make his performances so wonderful to listen to time after time. Mahler's meaning is never in doubt and it is Mahler who speaks, not some deputy seeking self-glorification in a personalised statement.

Then we come to Haitink's choice of tempos. How completely right they always

sound, how significant their contrasts and how they never fail to keep the music moving at exactly the right rate of progress from the first bar to the last. In current terminology the form is the message. There is no self-indulgence, no leaping, gesticulating Bernstein between the music and its audience. There is not even the always tempting sweetness of Kubelik to woo us. If anything, Haitink is of sterner temperament than his competitors. And among these I include the formidable Klemperer.

If you seek agreement — or disagreement — with these superlatives of mine, play the Scherzo of the Ninth which has three distinctly different tempos and hear how marvellously — to my way of thinking — Haitink deals with them. And if you remain still uncertain go on to the Rondo Burlesque finale and compare it with that of any other conductor's. I don't care whose.

Of course, in an integral recording of 10 symphonies by the same orchestra and conductor there are bound to be bars, even movements, that you might prefer in other hands. But over the whole oeuvre — and there are five discs in the first box and 10 in the second — my own personal reaction is one of deep satisfaction, a feeling that nothing can ever go wrong, and vast enjoyment of a style which, while always consistent, is never mannered or

monotonous.

I admit that the engineering doesn't always offer the same sheer beauty of sound as do some of Philips' competitors. But none, and I repeat none, of the others has captured such clarity of recording, a clarity that makes even the most complex polyphony and polytonality as easy to follow as a simple two-part canon. I feel absolutely safe in asserting that even the most industrious student of Mahler's music will hear in this magnificent set, things they have never heard before.

In his treatment of the 6th Symphony I am grateful that Haitink doesn't seek to pursue the composer's dark Germanic soul-searching. He gives us limpidity instead. He doesn't become hysterical in the climaxes. Instead you have controlled passion—and drama—which is never allowed to get out of hand. On no occasion does he miss the point of an ironic Mahler aside. And he just as skilfully avoids pumped up grandeur and orotundity.

Metaphysics is out. Haitink's cosmos never terrifies humanity. Man may be small in comparison to the rest of the universe but he can still fight with enormous resource things outside his true certainty. And that, I think, is Haitink's message in this truly great undertaking by conductor and orchestra. Emotion is unexaggerated, excitement never superficial. When excitement comes it is Mahler's own, not something imposed by the conductor. If what I have written gives you the impression that Haitink is at times staid and over cautious, please forget it. He plays the music for what it's worth. And no composer could ask for more.

In only one symphony, the 8th, do I prefer an entirely different performance, that by Solti and the London Symphony Orchestra for Decca. This is scored, as you probably know, for solo voices and many choruses and in this Solti's vast experience in conducting opera gives him a slight edge over Haitink. But I could quite comfortably live with the Haitink reading, and indeed, intend to do so. A highly recommended set.

Violin Concerto No 2 — warm, easily appreciated

SZYMANOWSKI — Violin Concerto No. 2. **WIENIAWSKI** — Violin Concerto No. 2. Henryk Szeryng with the Bamberg Symphony Orchestra conducted by Jan Krenz. Philips Stereo No. 6500 421.

Back in the 1930s Szymanowski had quite a vogue among the more adventurous record buyers. The Fountain of Arethusa was a great favourite, played, I seem to remember, by either Heifetz or Szigeti on a 78. It was a picturesque piece, as was the short piano item that Schnabel often included in his concerts. However he seemed to lose favour around the middle 1940s and this concerto, which I have never come across before, was recorded for the first time in 1967. Szymanowski died in 1937 and this second violin concerto was his last major work.

To the end of his life he paid constant but never plagiaristic homage to Chopin and Debussy and you find these influences persisting in the concerto under review. It is to Chopin that the work owes its strong Polish nationalistic flavour. As Denby Richards' sleeve notes point out, much of the material was taken from folk songs that the composer jotted down in the Tatras Mountains.

The result is a work at once warm, easily appreciated at first hearing, grateful to its performer and based on a secure formal structure. Its performance here is first class and Henryk Szeryng's beautifully shaped and intoned performance is very well matched by the support he receives from the Bamberg Symphony conducted by Jan Krenz. One hears too little recorded music by this fine orchestra which I once heard live in Bamberg and was very impressed, afterwards going to supper at a place where, among other things they sold "smoked" beer.

I should have thought that the coupling, the Wieniawski Second Concerto, would by now have outlived its usefulness. Yet it obstinately remains in the repertoire, is recorded by some of the world's finest violinists, and is still a favourite among amateurs, especially the less difficult Romance movement. Its main interest lies in the virtuosic material it provides for a player who likes that kind of thing. But Szeryng's reading happily plays down this aspect of the concerto which, to me, I much prefer to a flashier approach. But in doing so Szeryng leaves the listener in no doubt that, if he liked, he could make it all sound as showy as any other violinist playing

today. In this concerto also the Bamberg supply an impeccable accompaniment. The engineering is first class.

MOZART — Symphonies No. 39 in E Flat (K543) and No. 40 in G Minor (K550). Concertgebouw Orchestra conducted by Josef Krips. Philips Stereo No. 6500 430.

It is interesting to compare the Concertgebouw's playing for its resident conductor Haitink and compare it with what they do under visiting conductor Josef Krips. The playing under both conductors has all the Concertgebouw's customary excellence. But where, one suspects with good reason, under Haitink they could produce a dark urgent sound in the first movement of the G Minor you have, under Krips, a much too lethargic, easygoing mood. Going on to the two inside movements things improve considerably only to relapse again in the Finale which, although marked *allegro assai*, is taken at a much slower tempo.

By the way, Krips uses a largish orchestra which includes the clarinets that Mozart later introduced into the score.

The E Flat I found much more enjoyable. Although Krips seems never to be in a hurry, this leisurely attitude suits the music admirably. Indeed his whole performance has true elegance, even if an occasional dramatic point is dropped here and there. The sound is excellent but I think a more consistently good coupling of these two great symphonies might be made one of these days.

CHOPIN — Golden Hour of Chopin. Music of Les Sylphides. Barcarolle in F Sharp Major. Three Etudes from Op. 10, Nos. 3, 4 and 7; Three Etudes from Op. 25, Nos. 1, 9 and 11. Six Preludes from Op. 68. Nos. 3, 4, 15, 17, 20 and 21. Iso Elinson (piano). Astor Stereo GH510.

To my ear, and on my equipment, there seems to be a distinct difference in the quality of the recording on the two sides of this disc. Side 2 offers a shallow piano tone without much resonance, which I found was improved slightly by a small bass boost and treble cut. Things were made even worse by a surface that produced distinct growls alongside its prickles. On the first side the piano tone was much better and I got the impression that this side had been recorded at some later period than the first. However the whole exercise does not seem to be aimed at the critical, though it is generous with its playing time. It provides 60 minutes of entertainment at a budget price and as such should be successful. But oh, that Side 2 surface!

Elinson's playing is never less than competent though seldom inspiring. He chose for this recital what are probably the easiest records of Chopin's piano pieces. There are three Etudes from Opus 10, three from Opus 25, and six Preludes from Opus 68. All these are on Side 2. On Side 1 you have the piano pieces from which the ballet Les Sylphides was constructed and the F Sharp Major Barcarolle. Some of them are played well but most are just ordinary. However if you're looking for an hour's music at a reasonable price to play as a background to dining or conversing this should suit you.

Reader's Digest Classics

FESTIVAL OF LIGHT CLASSICAL MUSIC. Nine-record boxed set, various orchestras and conductors. Reader's Digest/RCA stereo.

If you're a long-time devotee of classical music, you'll almost certainly have many of the items, assembled in this set, scattered throughout your record library. If so, you may not want to buy them again, unless it is because the new set makes so many familiar items readily accessible.

On the other hand, if your record collection is of a lighter or more specialised kind this quite extensive collection of classical excerpts may prove to be an excellent investment by way of variety and for the guest who prefers something different from your own specialty.

To be sure, a similar purpose might be served by a handful of somebody's "favourites from the classics" but the single set does avoid duplication and it does offer convenience in handling.

There are something like 58 separate items on the 18 sides here and it is obviously not possible to list more than a few of them. Record 1 starts with "Capriccio Italien" and ends with "Ride Of The Valkyries"; in between are six other items including "Thunder and Lightning Polka."

Among the six items on record 2 are "Rosamunde: Entr'acts No 2" and "Hungarian Rhapsody No 2." The "Goodies" continue on record 3 with "Sleeping Beauty Ballet Waltz," "March Slave," "Zampa Overture," "Xerxes: Largo"

and "Dance Of The Hours."

Record 4 is devoted mainly to two longer items: Ravel's "Bolero" and "Carmen Suite."

Here are some of the titles on the remaining five records, picked at random: Poet and Peasant Overture — Invitation To The Dance — 1812 Overture — Figaro, Overture — Prince Igor, Overture — Socerer's Apprentice — A Night On Bare Mountain — Light Cavalry Overture — Marche Militaire — Artist's Life Waltz — William Tell Overture — La Traviata — Siegfried's Rhine Journey.

Orchestras include the New Symphony of London, Vienna State Opera — Filamonia di Roma, and Orchestre de la Societe Des Concerts Symphoniques. Of the conductors, Sir Adrian Boult is the best known.

All the items are listed on the labels and on the jackets but there are no notes about the music as such. Instead, an accompanying booklet discusses each of the 37 conductors represented.

In the time available I had no chance of listening right through the 18 sides and there were domestic reasons why I could not thunder them out at symphonic volume. Allowing for these limitations, I heard nothing in any of the tracks sampled to cause the slightest apprehension about either the technical or the musical quality. To be sure, the specialist could debate the relative merits of these and other performances but for us humbler mortals, Reader's Digest have assembled a very acceptable set of recordings. (W.N.W.)

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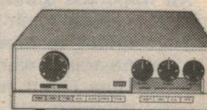
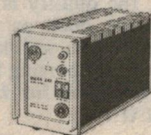
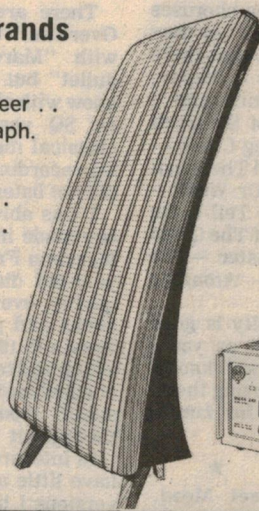
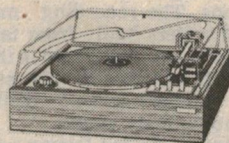
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Variety Fare

Reviews of other recordings

Devotional Records

THE BOONE FAMILY (The Family Who Prays) and the **First Nashville Jesus Band**. Stereo, Lamb & Lion LL-1006. (From Sacred Productions Aust, 181 Clarence St, Sydney and other capitals.)

The First Nashville Jesus Band gives the clue to the nature of this album — a gently rhythmic C & W sound that should have a wide family acceptance. There's a wide range of Gospel sentiment but, by and large, it's a happy sound with a message woven through. The songs may be unfamiliar but excellent diction avoids any problem on that account: Gloryland March — How Can You Refuse Him Now? — Dust On The Bible — Old Fashioned Singing — Bubbling In My Soul — The Family Who Prays — Help Me Understand — The Lord Is Counting On You — I'll Meet You In The Morning — Thank God — Old Country Church — He Will Set Your Fields On Fire.

An imported album, the packaging and sound quality are excellent, matching the performance itself. For happy family listening — recommended. (W.N.W.)

★ ★ ★ EXCITING SONGS ON THE WAY.

Presented by Cliff Barrows; Arranged and conducted by Ralph Carmichael. Stereo, Light LS-5621. (From Sacred Productions Aust, 181 Clarence St, Sydney, and other capitals.)

There are 22 tracks on the two sides of this new album but it is obviously not intended to be played a track at a time. The choruses and songs are all relatively short but they are bridged one into the other so that there is no break in the sound. It's a happy, predominantly vocal performance and I enjoyed it. Here are just a few of the track titles: Tell It Like It Is — A Living Circle — Cleanse Me — Every Time I Feel The Spirit — In Christ There Is No East Or West — Someone Loved Me First — Go Tell It On The Mountain — When I Think Of The Cross — Were You There? — My Master — We Are More Than Conquerors — Amazing Grace.

An imported album, the quality is good and the youth choir is as good as you'd expect having in mind the two well-known Gospel musicians who are supporting them. Another one I can recommend for family Gospel listening. (W.N.W.)

★ ★ ★
WITH YOU I AM. Sister Janet Mead. Stereo, Festival L-35148.

Festival Records are rather proud of this new all-Australian recording by the very

gifted Sister Mead — an album which, I imagine, will find a ready acceptance among record buyers. Most of the twelve tracks feature the solo voice against a driving rhythm, with further support from orchestra, chorus and occasional touches of electronic sound. The treatment and the lyrics are, for the most part, modern Gospel but it certainly isn't "way out" and, dominating it all, is the voice and the message of Sister Mead.

The best-known number is "The Lord's Prayer" in its now familiar modern setting. The others are: The Earth Is Filled — Gloria — Father, I Put My Life In Your Hands — Hold On — Take My Hand — The Ten Commandments — With You I Am — Keep Me Safe — Lamb Of God — God, My King — He Is King.

The sound quality and balance are good and, having in mind the strong local interest in the recording, it's one that many will be happy to have in their collection. Recommended. (W.N.W.)

Instrumental, Vocal and Humour

TCHAIKOWSKY. 1812 Overture. Romeo and Juliet. Marche Slave. The London Symphony Orchestra conducted by Andre Previn. His Master's Voice SQ Quadraphonic Q4. OASD. 2894.

There are many versions of the "1812 Overture" which are frequently teamed with "Marche Slave" or "Romeo and Juliet" but this is the only version that I know with all three pieces together. And it's an SQ version. And I suppose if any classical music is going to be benefited by SQ recording this should be it. However, I did not listen to it on a four-channel system.

I was able to compare this version with one made in 1964 by the LSO conducted by Massimo Freccia. By comparison, the ten-year-old disc was far superior in sound quality, even though it now has its share of clicks and pops. The recording made by Previn in 1973 suffers badly from tape hiss which will tend to be emphasised in the four-channel mode. In addition, the disc seems to suffer from "inner groove distortion" throughout much of its length.

In interpretation, Andre Previn seems to have little advantage over the many other versions I have heard. In any case, if you only listen to the "1812" occasionally the differences seem to come down to "more thunderous cannon" and "more clangorous

bells." Much the same can be said of the other two pieces.

Unless you are particularly keen to obtain this selection of Tchaikowsky pieces on an SQ disc, you are recommended to shop around before deciding on this album. (L.D.S.)

★ ★ ★
THE NUTCRACKER — complete ballet (Tchaikowsky), Suisse Romande Orchestra, conducted by Ernest Ansermet. Stereo, Ace of Diamonds SDDA 378/9. Two-disc set in folding sleeve.

This medium-priced set provides a cheaper alternative to the full price Decca set reviewed in these columns a few months ago. While the Decca recording, with the London Symphony conducted by Andre Previn, must be considered superior musically as well as technically, it is around \$4 dearer. This performance cannot be discounted, as it is certainly a very acceptable one, as one would expect from such an experienced recording combination. Although the recording must be at least ten years old, the sound is good, with well-balanced and clearly defined stereo spread. My recommendation would be to go for the Decca set if you can afford the extra few dollars, but if price is a serious consideration, regard this set as a suitable alternative. (H.A.T.)

★ ★ ★
A CLASSIC MOOG EXPERIENCE. The Sound of the Criss Cross. Stereo, Barclay L-35062 (Festival).

If you're wondering about the significance of "Criss Cross," there are no notes whatever on this jacket to enlighten you. What I can tell you is that the sound on this album is a mixture of Moog, orchestra and human voice. They alternate, they substitute, they blend, phrase to phrase, in short, they criss cross! And I'm delighted to report that the whole thing is very skilfully executed and a tribute to the skill of a whole array of musicians, vocalists — and panel operators!

As indicated by the title, the themes are borrowed from the classics: L'Arlesienne — Sonata XI — The Tambourine — Barber Of Seville (Figaro) — Norwegian Dance No 2 — William Tell Overture — Pathetique Sonata — Turkish March — Habanera (Carmen) — The Fifth Season — Mozart Symphony No 40.

You don't like fractured classics? Fair enough but, if you suffer no such inhibitions, my tip is that you'll like this Moog/orchestral criss cross. The quality is very good indeed and it spreads nicely in simulated quadraphonic. Recommended. (W.N.W.)

★ ★ ★
HAYDN — Quartet in E flat Op 33 No 2 "Joke." Quartet in F Op 33 No 5 "Serenade." Quartet in D minor Op 76 No 2 "Fifths." Janacek Quartet. Ace of Diamonds stereo SDDA 285.

Recorded in 1964 by Decca this very pleasant album is now re-released on the economy label Ace of Diamonds at the favourable price of \$4.50. Recording quality is very good and surface noise is low.

Playing by the highly reputed Janacek Quartet is exemplary — while the playing is highly disciplined, it has not been to the detriment of feeling. Whether you are collecting records on a budget or not, we can highly recommend this disc. (L.D.S.)

Reviews in this section are by Neville Williams (W.N.W.), Harry Tyrer (H.A.T.), Leo Simpson (L.D.S.), Gil Wahlquist (G.W.), and Norman Marks (N.J.M.).

HOMETOWN BLUES. Sonny Terry & Brownie McGhee. Mainstream stereo L 35074. Distributed by Festival Records Pty Ltd.

I was quite impressed with this album of blues by blind Sonny Terry on harmonica and Brownie McGhee on guitar. This is a very straight production of what you could call "honest to goodness" blues. These two have been playing the blues since way back in the thirties and by the time the tracks on this album were cut in the early fifties, they were certainly well practised. The music just flows like tears down a new bride's cheek.

Reprocessed for stereo, the recording quality is good without being startling — it doesn't matter all that much with this sort of material anyhow. Surface noise is low.

Tracks are: Mean Old Frisco — Man Ain't Nothin' But A Fool — The Woman Is Killing Me — Crying The Blues — Meet You In The Morning — Stranger Blues — Feel So Good — Bad Blood — Lightnin's Blues — Forgive Me — Sittin' On Top Of The World. (L.D.S.)

★ ★ ★

NOW WE ARE SIX. Steeleye Span. Chrysalis stereo L 35100.

A most unusual record, this. In some ways, it follows on from the album entitled "Gryphon" which I reviewed in these columns in May. It, too, is a mad mixture. It starts off with a lively Irish jig then moves to a plaintive lament, "Drink Down the Moon," with bass drum accompaniment that feels like a kick in the chest when it is played at a good level.

Side 2 has the following tracks in its mad mixture: "Two Magicians," a bawdy tune if ever there was one, with clever lyrics; "Edwin," a tune such as the Beatles might have originally composed, and "Twinkle Twinkle Little Star," yes, the original number you learnt in kindergarten without any twist.

Six people make up the group: Maddy Prior, Robert Johnson, Peter Knight, Tim Hart, Rick Kemp, Nigel Pegrum and David Bowie who appears on one track playing the alto sax. They play a diverse set of instruments, from mandolin to synthesiser.

The rest of the ten tracks are: Mooncoin Jig — Long A-Growing — Now We Are Six — Thomas The Rhymer — Seven Hundred Elves — To Know Him Is To Love Him.

I haven't a clue where Festival found this group but it's a weird and wonderful mixture and I hope they release more of the same. Recording quality was very good. (L.D.S.)

★ ★ ★

AIN'T IT AMAZING, GRACIE. Buck Owens and the Buckaroos. Stereo, Capitol ST 11180.

Buck Owens' modern style of C & W, with a driving beat, background rhythm, amplified instrumentals and supporting mixed choir, is a far cry from such originals as the Carter Family and other traditional C & W artists, but it commands a considerable amount of support. If you are included among his admirers, this program, consisting of eight numbers composed by Owens himself plus two others, should appeal. The title track has of course attracted considerable attention already — the others not so much. "Old Faithful" has nothing to do with the popular cowboy ditty of the 1930s

ENCYCLOPAEDIA OF THE ORGAN, VOLUME 7

ENCYCLOPAEDIA OF THE ORGAN, VOLUME 7. The Nordic Organ; The complete organ works of Diderik Buxtehude, record one. Marie-Claire Alain at the Marienkirche organ, Halsingborg. World Record Club stereo S / 4980.

This is a further volume in the massive 18-LP Erato "Encyclopaedia of the Organ" collection being released in Australia by WRC. It is of especial interest to this reviewer, both because of the music and because of the organist.

There are not that many recordings of Buxtehude's music, considering that he was a composer (and performer) who had a very profound influence on J. S. Bach. It is therefore very welcome that his complete organ works were included in this collection; it will broaden the available readings very significantly.

In this case lovers of 17th century organ music are particularly fortunate, because the performer is Marie-Claire Alain, the erudite and extremely gifted French

woman organist. In my opinion, she is without doubt in the very top echelon of living classical organists. Her playing of Bach is incredibly satisfying in its blend of clarity, appropriateness of registration and sheer empathy; it comes as no surprise that she brings these same talents to the music of Buxtehude on this disc.

Volume 7 includes the Prelude, Fugue and Chaconne in C, the Chaconne in E minor, the Toccata in F major, and the Preludes and Fugues in A major, F sharp minor, E minor, A minor and C. And Mme Alain's readings of these pieces are very satisfying indeed. Full details of the sources and the registration are given in the accompanying notes, which also include comments by Mme Alain on registration and ornamentation. The organ is very suitable for this sort of music, having been built in 1960 by Marcussen to a neo-classical specification.

For baroque organ lovers, an outstanding recording in every way. (J.R.)

but the tune has distinct resemblances. "When You Get To Heaven" is more reminiscent of the traditional C & W style. The sound and stereo are entirely satisfactory. (H.A.T.)

★ ★ ★

ELECTRA GLIDE IN BLUE. Movie Sound Track United Artists L34982. Festival Release.

I sometimes wonder what the recording companies have in mind with the release of so many sound tracks, particularly with

snippets of dialogue as in this disc, complete with a sprinkling of rough language. However the musical content helps make up for it. It is fairly easy to get the gist of the action and this tends to put things together. One very interesting part of the opening is the discourse between two American motorcycle police and the sound of one of them starting his Harley Davidson and riding off across the lounge and disappearing under the television set — acoustically that is! The marvels of stereo. The quality is good and the stereo image put to good use. (N.J.M.)

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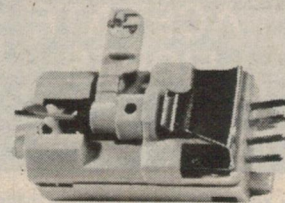
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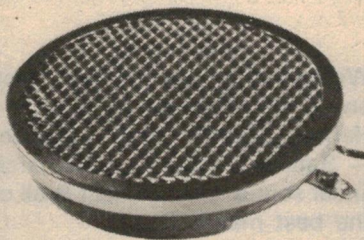
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VARIETY FARE

BY YOUR SIDE. Peters and Lee. Philips
stereo 6308 192.

Anyone who has seen this very attractive singing duo on television will be interested in this record. In spite of Lennie Peters' blindness, he and Dianne Lee seem to have a special rapport which is very charming to watch. On record they perhaps don't come across in such a special way but they are still very pleasant. On some tracks they tend to be drowned out by the orchestra.

Recording quality is good and surface noise low.

Twelve tracks are featured: The Old Fashioned Way — If — All I Ever Need Is You — Stars Feil On Alabama — Raining In My Heart — Everybody Needs A Rainbow — United We Stand — Until It's Time For You To Go — Nevertheless — She's About A Mover — Loving Baby — By Your Side. (L.D.S.)

★ ★ ★
NON-STOP CAROLE KING. The Sunset
Festival Orchestra, Harlequin L25110
Festival release, \$3.99.

Carole King's song writing efforts are certainly well represented on the hit charts and this largely orchestral version demonstrates the reason for her popularity, with fifteen hits such as: You've Got A Friend — Goin' Back — It Might As Well Rain Until September — Where You Lead — Hi-de-Ho — So Far Away — Go Away Little Girl — A Natural Woman. The quality suffers a little from an edginess on the opening of side one, but apart from this, I have no quarrel. An enjoyable disc for dining or background music. (N.J.M.)

★ ★ ★
THE WORLD OF VERA LYNN Vol 15.
SPA308 Decca EMI Release.

Vera Lynn never ceases to amaze me with such a youthful voice for someone who has been on the scene since the 1939-45 war and



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before. On this LP she gives a sensitive reading of thirteen favourite romantic ballads such as: Close Your Eyes — Faraway Places — My Happiness — If I Am Dreaming — As Time Goes By — Where Are You — Don't Blame Me — Goodnight My Love.

The recording is from mono originals, reprocessed for stereo. This would tend to date the recording but the quality is good, nevertheless. (N.J.M.)

★ ★ ★
BUDDHA AND THE CHOCOLATE BOX.
Cat Stevens. Island Records stereo L 35141.

Cat Stevens' new album has been released with his Australian visit. This visit plus the fact the album provides more of the Cat Stevens' formula: innovative instrumentation, clever lyrics and Cat Stevens' unique vocal style. Those who want to sing along can do so with the words printed on the record sleeve.

Recording quality is good, though it struck me that it was not as good as his last album "Catch Bull At Four." Sibilants tended to be overemphasised and stringed instruments a little edgy. Surface noise was low.

Songs presented are: Music — Oh Very Young — Sun C79 — Ghost Town — Ready — King Of Trees — A Bad Penny — Jesus — Home In The Sky. (L.D.S.)

★ ★ ★
YALE CONCERT. Duke Ellington and his
Orchestra, Fantasy Records. L35087
Festival Release.

My first playing of this enjoyable record coincided with the sad news of the Duke's passing in a New York hospital after a serious illness. The world of music has lost one of its all-time greats. Recorded in one of the older halls at Yale university, this session has the ambience typical of a live performance before an appreciative audience in 1968.

The titles are: The Little Purple Flower — Put-Tin — A Chromatic Love Affair — Boola Boola — Warm Valley — Drag —

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Salome — Swamp Goo — Up-Jump — Take the A Train. The personnel on the disc, apart from Ellington, are Cat Anderson, Cootie Williams, Mercer Ellington, Herbie Jones, Lawrence Brown, Buster Cooper, Chuck Connors, Johnny Hodges, Russell Procope, Paul Gonsalves, Jimmy Hamilton, Harry Carney, Jeff Castleman and Sam Woodyard. The quality is excellent for a live performance. I hope you enjoy it as much as I did. (N.J.M.)

★ ★ ★
GOOD TIME CHARLIE. Charlie McCoy. Monument stereo L34970. Distributed by Festival Records Pty Ltd.

Charlie McCoy's harmonica and a bunch of other enthusiastic musicians are teamed up here to produce the best Charlie McCoy album I've heard. Lively arrangements and "foot-tappin'" rhythm all the way through. Recording quality is good apart from some inner groove distortion. Surface noise is low.

Eleven tracks are featured: Good Time Charlie — Is Anybody Goin' To San Antone — Soul Song — Something — Minor Miner — Don't Touch Me — John Henry — Till I Get It Right — Louisiana Man — Shenandoah — Orange Blossom Special. (L.D.S.)

★ ★ ★
GLEN CAMPBELL'S GREATEST HITS. Glen Campbell. World Record Club stereo S 5536.

For those wanting the best of Glen Campbell's hits sung by Glen Campbell and not played by some anonymous orchestra, here is the record. Quality is good.

Twelve tracks are featured: Galveston — The Dock Of The Bay — Wichita Lineman — Gentle On My Mind — Honey Come Back — If You Go Away — Bridge Over Troubled Water — Folk Singer — Until It's Time For You To Go — You'll Never Walk Alone — Rose Garden — It's Only Make Believe. (L.D.S.).

★ ★ ★
IT'S HAPPENING NOW. Ronnie Aldrich, his two pianos and the London Festival Orchestra. Stereo, World Record Club WRC S/5575. (605 Camberwell Rd, Hartwell, Vic 3124).

Most of the duo-piano work I seem to have heard lately has been done by Ferrante and Teicher, but this WRC album comes as a reminder that Ronnie Aldrich can rightly claim some of the limelight. Yet, oddly

enough, some of the sound here, with the London Festival Orchestra, reminds one quite strongly of Liberace.

Anyway, Ronnie Aldrich is in that league as he plays: Hey Jude — Ride My See-Saw — Concerto De Aranjuez — Light My Fire — Scarborough Fair — Both Sides Now — Theme From Mozart Piano Concerto No. 21 — Soulful Strut — The Nature Of Love — I've Gotta Be Me — Little Green Apples — For Once In My Life.

The piano tone is hard and clean and the twelve tracks add up to good value for prospective purchasers. (W.N.W.)

★ ★ ★
MANUEL AND THE MUSIC OF THE MOVIES. Stereo, World Record Club S/5534. (605 Camberwell Rd, Hartwell, Vic. 3124).

It should hardly be necessary to observe that the strings, guitars and voices of the Manuel orchestra specialise in smooth, melodic sound and that's what you get on the twelve tracks of this album. Without being in any way dull, it's very, very easy on the ear.

The twelve tracks are: Wandrin' Star — Women In Love — Midnight Cowboy — Life Goes On And On — The Lonely Ones — Windmills Of Your Mind — Raindrops Keep Fallin' — A Time For Love — The Story Of Santa Vittoria — One Brief Summer — On Days Like These — Love Theme From Romeo and Juliet.

A Columbia recording, released through W.R.C., the quality is right up to standard. Recommended "soft lights and sweet music" fare. (W.N.W.).

★ ★ ★
FIDDLER ON THE ROOF. Ferrante and Teicher. Stereo, United Artists (Festival) SUAL-934364.

Backed by their own orchestra, conducted by Arnold Eidus, Ferrante and Teicher could hardly fail to please with this program of music from "Fiddler On The Roof". And please they certainly do, with a performance that is sparkling and alive.

On the nine tracks are: Overture — Now I Have Everything — To Life — Fiddler On The Roof — Matchmaker — If I Were A Rich Man — Sunrise, Sunset — Do You Love Me? — Miracles of Miracles.

The quality is excellent and the two Baldwin pianos sound particularly good. In fact, this must be one of F&T's best albums to date. Hear it. (W.N.W.).

CARRY ON SMOKING AND DIE

CARRY ON SMOKING AND DIE. Contour (Festival) L-15272.

I must confess that, when this album turned up in the batch to be reviewed, I didn't know whether to expect a helping of sick humour, or protest songs, or what!

In fact, it turned out to be a serious recording by a registered medical practitioner who has had ten years' experience in the use of hypnosis in medical situations.

The whole of side 1 is concerned with inducing the listener simply to relax. He — or she — is invited to settle down alone by the record player, to stretch out on an easy chair, to listen and relax. "You are completely and utterly relaxed. Your eyelids feel very, very heavy..."

No, it didn't work with me, because I was

in the anomalous position of a wide-awake critic having to listen to going-to-sleep talk. What I can say is that it is the usual approach, which apparently carries the endorsement of the doctor's fellow practitioners.

Side 2 is largely a recap of side 1 except that, part way through, with the listener hopefully in a state of complete acquiescence, the evils of smoking are listed. The listener is told that, henceforth, the whole idea of smoking will be repulsive. Because of this, they will give it up, easily and without any particular effort of will.

As a non-smoker, the impact was likewise lost on me but, if you have a tension problem in general or a smoking problem in particular, this unusual record might just be able to assist. It's over to you. (W.N.W.)

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VARIETY FARE

VISIT BRITAIN WITH THE BAND OF THE GRENADIER GUARDS. World Record Club stereo S 5599.

This is not your usual album of brass martial music — fine stirring stuff. No, this is more of a musical travelogue with the Grenadier Guards providing music which is evocative of life in the British Isles. As with much pictorial music, it can be trite and annoying to listen to unless you're in the mood for it. To my mind, the Grenadier Guards should stick to marches.

Record quality was good throughout.

Some of the tunes featured are: Westminster Chimes — Oranges And Lemons — The Grand Old Duke Of York — The Eton Boating Song — Burlington Bertie From Bow — She's A Lassie From Lancashire — John Peel — England Swings — Scotland the Brave — Rule Britannia. (L.D.S.)

★ ★ ★

THE WORLD'S MOST GLORIOUS MELODIES. Reginald Kilbey and his strings. World Record Club stereo S 5576.

The "world's most glorious melodies" are: Melody in F — Songs My Mother Taught Me — Panis Angelicus — Cavatina — Barcarolle from "The Tales Of Hoffmann" — Chanson Triste — Plaisir D'Amour — Tramerei — Che Faro from "Orpheus" — Poeme — Pantomime from "Zemire Et Azor" — Waltz In C Sharp Minor.

Recording quality is good but instrumental arrangements are a little lacklustre. (L.D.S.)

★ ★ ★

Jazz and Rock . . .

PIANO RAGS BY SCOTT JOPLIN. Joshua Rifkin. Stereo. Nonesuch Records H-71248 / 64.

That most delicious of all improvised music styles, ragtime, is superbly demonstrated for us on this two-LP set. Volume one of the two was honored with a Record of the Year award by the American Stereo Review.

The ragtime form derives from a 16-bar pattern, the themes being played in four groups of four bars each.

"The Entertainer", played here by Rifkin, displays this to perfection. This is the theme of the movie "The Sting".

The particular charm of Joplin was the melancholy which was never very far away. The rags on the album were composed between 1899 ("Maple Leaf Rag") and 1914 ("Magnetic Rag").

They are exacting to play, each a masterpiece. Joplin stopped writing rags to concentrate on the second of two operas.

Rifkin's performance follows Joplin's dictum that rags shouldn't be played too fast. He captures the rhetoric of "Bethana—a concert Waltz" written by Joplin to show that ragtime was a vehicle for themes of some depth. (G.W.)

★ ★ ★

BUNNY BERIGAN, HIS TRUMPET AND ORCHESTRA. Mono. RCA LPV-581-G.

Five tracks recorded by Berigan as a tribute to Bix Beiderbecke form the centerpiece of this outstanding historic release.

None of the tracks have been on LP before, although they exist on 78's in collections.

Berigan came from the same background as Beiderbecke. They shared the same heavy drinking habit.

Berigan also had a lyrical trumpet style and it was this which caused him to be compared with Beiderbecke.

The five Beiderbecke compositions were arranged for small orchestra by Joe Lipman.

They are "In A Mist", "Davenport Blues", "Flashes", "Candlelights" and "In The Dark", being important examples of jazz impressionism. It surprises me that they have not been used in the repertoire of classical orchestras which claim to be "with it".

Solos are sparse in the performances, which were written to display Beiderbecke's unusual harmonies.

The other big band performances on the disc are good workmanlike examples of thirties swing, featuring tenor player Georgie Auld (then a teenager) with Berigan. Berigan died of cirrhosis of the liver in 1942. (G.W.)

★ ★ ★

YALE CONCERT. Duke Ellington and his orchestra. Stereo. Fantasy Records L 35087.

The interesting thing about this LP by the late Duke Ellington is that it contains some material not previously heard on disc.

Main among them is "The Little Purple Flower" a two-part suite in which the Duke, with typical wit, paints a musical portrait of the decline and fall of a drug plant.

Another piece of typical Ellingtonia is "A Chromatic Love Affair" featuring Harry Carney's tenor saxophone.

Ellington features Johnny Hodges in a medley of two excellent tunes, "Warm Valley" and "Drag".

The record was made in 1968. (G.W.)

★ ★ ★

BIG BAND BAGS. Milt Jackson. Stereo. Milestone L45321 / 2.

This two-LP set is one of an outstanding series of classic jazz of the sixties. Most of it, like this one, was originally on the Riverside label. Marketing of Riverside was spasmodic in Australia in the old days.

Many collectors will be hearing this jazz for the first time.

The Milt Jackson record has the vibraphone player in a band conducted by Tadd Dameron and featuring Clark Terry, Jimmy Cleveland, Jerome Richardson and Jimmy Heath, among others.

Jackson plays the ballad style which shows his talent so well and he also rips along on swingers like "Namesake".

It's a sophisticated session of great charm and excitement. (G.W.)

★ ★ ★

HOME TOWN BLUES. Sonny Terry and Brownie McGhee. Mainstream L 35074.

This is vintage Sonny and Brownie material, recorded in the early fifties for Mainstream, a jazz label which is being promoted in Australia by Festival. Sonny on harmonica and Brownie with guitar and vocals take jazz back to its roots with a recital of blues subject matter in "Bad Blood", "Lightnin's Blues", "Feel So Good" and "Crying The Blues".

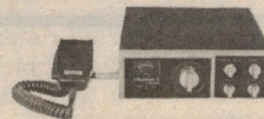
The pair are accompanied on some tracks by drums, bass and piano. (G.W.)

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BARLOW-WADLEY XCR-30 features include: Selectable USB LSB, CW & AM reception, frequency readout 10kHz throughout the entire range, calibration accuracy within 5kHz, antenna resonator, tuning signal strength meter, zero-set control, clarifier-vernier tuning, MHz & kHz tuning controls, telescopic antenna. Power source: 6 type D dry cells; provision for external DC power supply. Weight 4lbs; size 11 1/2 x 7 1/2 x 4in.

ALL FOR \$225.00 F.O.R.



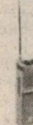
KEN KP-202. 2W, 144MHz band. FM. Hand held transceiver with crystals for 4 channels provision for 6 channels. \$150.00 KCP/2 NICAD battery. Charger & batteries. \$35.00.

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1: 1: AM 535 — 1600kHz. 2: Marine 1.5 — 4MHz 3 & 4 combined SW 4 — 12MHz 5: 30 — 50MHz 6: 88 — 108MHz 7, 8 & 9 combined VHF Aircraft 145 — 174MHz incorporating weather band. Slider controls, dial light, fine tuning control, flip-up time zone map, telescope antennas, complete with batteries and AC cord. Price \$79.50.



AM / FM / AIR-PB-WB SOLID STATE RADIO Battery/Electric \$37.50.

SPECIFICATIONS

Transistors: 12 transistors & 8 diodes. Frequency: FM88 — 108MHz, AM 540 — 1600kHz AIR-PB 108 — 174MHz. Power Output: Maximum 500mW, undistorted 280mW. Speaker: 3in 8 ohms. Earphone: Magnetic 8 ohm. Power source: DC 6V UM-2 x 4pcs or AC 230V. Antenna: Ferrite bar for AM, Rod Antenna for FM / AIR-PB-WB. Controls: Volume (w/on-off switch). Selector (AM/FM / AIR-PB-WB). Accessories: Earphone & batteries. Dimensions: 3 3/4in x 6 3/4in x 9 3/4in. Weight: Approx. 3 lb.

Product reviews & releases

Low cost Data Precision DVM

A recent addition to the ranks of low-cost digital multimeters is the Data Precision model 134, available from Kennelec Systems. Using a 3½-digit seven-segment gas discharge readout with large, easily read numerals, it offers five functions and 22 ranges at a very attractive price.

The model 134 is produced by Data Precision Corporation, of Wakefield, Massachusetts, a well-established US manufacturer in the field of digital instruments. It represents their bottom-of-the-line instrument, intended as a modern replacement for the traditional VOM in servicing and similar applications.

The instrument measures about 14 x 10 x 21 cms overall (W x H x D). Its case is of steel with moulded plastic ends, and is fitted with a combined handle and tilting bail. The front panel is finished in metallic satin, with lettering silk-screened in black and blue.

The readout uses Sperry-type gas discharge tubes, with seven-segment characters about 13mm high. These are very bright, and this together with the size makes them easily readable even at a distance of many metres in a brightly lit room. The display has three full digits together with an over-range 1 and polarity indication.

The five measuring functions provided on the model 134 are DC and AC voltage, DC and AC current (yes, I know these terms are strictly inaccurate, but I'm tired of being the only member of the regiment in step), and resistance. There are four ranges for each of the voltage and current functions, with nominal FSD values of 1, 10, 100 and 1000 volts and milliamps respectively. The resistance function has six ranges, spanning from 100 ohms to 10M — again in terms of nominal FSD.

All ranges have a 100pc over-range factor, so that in practice they have an FSD of 1999 instead of 1000. This both gives considerable range overlap and also extends the upper ranges of the functions. The resistance function is therefore capable of reading to 20M, while breakdown considerations limit the voltage limits to 1500VDC and 1000V AC (RMS). Both current ranges extend to 1.999A, using a third input jack.

Higher voltages, up to 30kV, may be measured using an optional isolation probe, which provides very low input loading for measurements in high impedance circuitry. The instrument has automatic polarity selection and indication on all four voltage and current ranges.

Maximum resolution for voltage is 1mV, for current 1µA, and for resistance 0.1 ohm. The rated accuracy for DC volts is 0.1pc of rdg together with 0.2pc of FSD, except on the 1000V range, where it is 0.6pc and 0.4pc respectively. Equivalent figures for the AC

The Data-Precision 134 digital multimeter is easy to drive, has a large display and a modest price tag.



volts ranges are 1pc and 0.6pc, and 2pc and 0.6pc; for DC, 0.9pc and 0.5pc, and 1.8pc and 0.5pc; for AC 1.3pc and 0.5pc, and 2.3pc and 0.5pc; and for resistance, 0.8pc and 0.5pc and 1.9pc and 0.5pc.

In each case the figures represent bipolar tolerances, and the second sets of figures are for the uppermost ranges. The rated frequency response of the AC ranges is from 50Hz to 1kHz, for full rated accuracy.

When we opened the sample instrument pictured, we found the construction very sturdy. Fairly obviously the model 134 has been designed down to an attractive price, but this has been done with care and forethought. The complete circuit is wired on a single large printed board mounted horizontally, except for the readout devices and their special driver ICs. These are on a small plug-in vertical board.

The board appears to be well laid out, with just about all parts readily accessible. And it is a pleasure to note that it sports a complete part identification legend, silk screened on the top of the board. This is a feature one finds all too rarely on instruments of much higher price.

The model 134 comes complete with a 22-page instruction manual, test probes and a one-year manufacturer's warranty. The manual is not perhaps among the most clearly written I have come across, but is quite thorough and includes both a full schematic circuit and a board wiring diagram, together with general maintenance data.

From the description given of the operation of the model 134, it would seem that its measurement system is basically

voltage to frequency conversion. This involves a novel voltage to current converter which also performs rectification of AC signals. As such it represents a very interesting approach in the quest for a lower-priced DVM.

However the technique seems to involve the use of the mains frequency as a timebase, and this is unfortunately less valid here than in the US. The short-term mains frequency accuracy out here is considerably poorer than is maintained over there, and I suspect that this will reduce the accuracy of the model 134 by a significant extent.

Mind you, this is being a little pedantic. The basic accuracy of the instrument is still likely to be around 1pc, which is at least three times better than all but the most expensive analog VOMs.

In use the model 134 is very easy to drive, and its big display numerals give all the

expected advantages of digital readout. It seems quite good in terms of zero stability, and its accuracy quite adequate for all likely servicing and general measuring situations.

At the quoted price of \$150 it would appear to be very good value for money.

Enquiries regarding the model 134 and other instruments in the Data Precision range may be directed to Kennelec Systems, at 142 Highbury Road, Burwood, Victoria, 48 Oxford St, Paddington, NSW, or representative in other states. (J.R.)

SCR-Transistor array on one chip

A new addition to the range of special consumer integrated circuits manufactured by RCA is the CA3097E. This device consists of five independent and completely isolated elements on one chip.

1. Uncommitted NPN Transistor.
2. Sensitive-Gate Silicon Controlled Rectifier (SCR).
3. Programmable Unijunction Transistor (PUT).
4. PNP / NPN Transistor pair.
5. Zener Diode.

Applications for the device include timers, light dimmers, oscillators, comparators, SCR triggering and pulse circuits.

For further information please contact Amalgamated Wireless Valve Company Pty Ltd, 554 Parramatta Road, Ashfield, NSW 2131. Phone (02) 797-5757. Telex 24530.

New battery c

Many attractive features are offered by this new battery charger from A & R Soanar, including two charging rates and both 6V and 12V operation.

The A & R Soanar Electronics group has just released an all purpose battery charger designed to meet the varied charging requirements of the lead-acid batteries used in cars, trucks, caravans, boats, motor-cycles, etc.

Designated Battery Charger 4, the new unit has modern styling and is compact, robust and very portable. It weighs 2kg and measures 14 x 8 x 13 cm.

Suitable for charging both 6V and 12V batteries, Charger 4 has several unique features. It incorporates two distinct charging circuits, nominated HI and LO, which are selected by a switch on the front panel of the unit.

The HI position provides a high current boost charge, peaking at 6 amps, for quickly energising completely discharged batteries. On this setting it is possible to obtain sufficient charge in a dead flat battery to start a car within 2-3 hours. Naturally the actual time depends upon the age and condition of the battery concerned. Full charging takes approximately 12 hours.

Many chargers on the market provide a single charging rate, usually in the vicinity of 4A. However Charger 4 also incorporates a trickle charge facility, designed specifically for continuous charging. (Prolonged charging in excess of 1A is not advisable, as battery cells commence to deteriorate with high current once the battery has become fully charged).

The LO position on Charger 4 provides a 1A charging rate, and batteries may be left on continuous charge at this rate for periods of at least a week without causing damage to either battery or charger.

Continuous trickle charging has the advantage of maintaining a battery in peak condition and making it immediately available, fully charged, when required. This is particularly important for batteries which are only used intermittently, such as those fitted to power boats, caravans, emergency lighting systems or the second car.

Charger 4 also features an internal safety

cutout switch, to protect the unit from damage in the event of an overload, short circuit, incorrect selection of battery voltage or the inadvertent reversal of lead polarity. The action of the cutout is automatic, and self-restoring when the fault is corrected.

The casing of the unit is coloured bright orange to make it stand out from its surroundings, and serve as a visual reminder of any charging programme. An ammeter with large scale and reading from 0 to 8A allows monitoring of the charging rate and gauging of the charge level reached.

ordinary soldering tool and at low cost using a specially treated absorbent braid called SODER-WICK. Almost any size of solder joint can be completely desoldered in a second, by placing the end of the Soder-Wick on the joint, applying the flat face of the iron tip to it, and removing both when the solder melts.

No flux is needed, so flux spatter is eliminated. Residue, if any, is pure non-corrosive and non-conductive resin. Holes are clean, and the entire joint surface is ready for re-soldering without further cleaning. The thirsty wicking action leaves even plated-through PCB holes clean. Soder-Wick also prevents thermal damage to components by acting like a heatsink.

Distributors of Soder-Wick are Royston Electronics Pty Ltd, of 22 Firth Street, Doncaster, Victoria.

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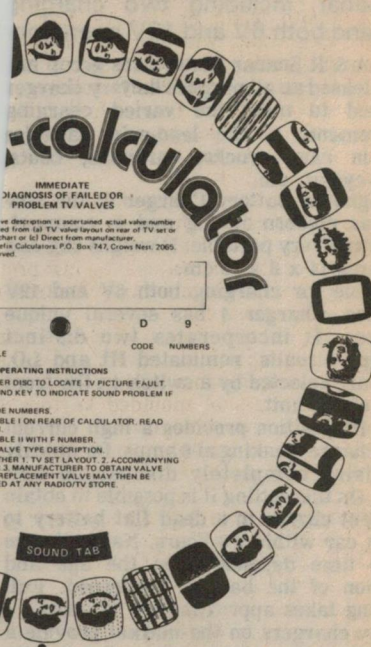
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Calculator from DSE



IMMEDIATE DIAGNOSIS OF FAILED OR PROBLEM TV VALVES

Valve description is ascertained actual valve number set from list TV valve layout on rear of TV set or part or full Direct from manufacturer. Tele Calculators, P.O. Box 747, Crows Nest, 2005, NSW.

CODE NUMBERS

OPERATING INSTRUCTIONS
INNER DISC TO LOCATE TV PICTURE FAULT
SOUND KEY TO INDICATE SOUND PROBLEM IF

D CODE NUMBERS
ENTER TABLE 1 ON REAR OF CALCULATOR. READ NUMBER.

5. ENTER TABLE 2 WITH F NUMBER.
6. OBTAIN VALVE TYPE DESCRIPTION.
7. CHECK EITHER 1. TV SET LAYOUT 2. ACCOMPANYING CHART OR 3. MANUFACTURER TO OBTAIN VALVE NUMBER. REPLACEMENT VALVES MAY THEN BE PURCHASED AT ANY RADIO/TV STORE.

SOUND TAB

As an aid to the "do-it-yourself" types, Dick Smith Electronics is now offering the Tele-fix-calculator, a diagnostic chart which pinpoints the valve, or valves, most likely to be the cause of TV receiver faults. All one simply does is rotate the circular dials to display the relevant picture and sound symptoms and read off the resultant code number. The suspected valve types are then read from a table on the back of the Tele-fix.

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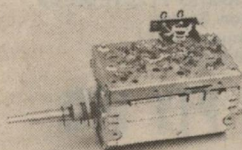
NEW Postage Rates Please Add Extra

TV Picture Tubes. New in cartons. 21 inch 110 deg. \$22, 17 inch 110 deg. \$18.

TV channel change and fine tuning knobs 75c a pair.



TV tuners new in valve type or transistor \$10 each.



BSR latest 202 top model of BSR range of record players \$52 including Magnetic Cartridge. Pack and post \$1, interstate \$2.

100 mixed condensers micas polyester ceramic fresh stock \$2 per 100 pack and post 25c.

Stereo amplifier and tuner solid state 10 watts per channel RMS new well known make \$50.

Speaker transformers 7000 to 15 Ohm 3 1/2 watt \$1.25.

Perspex tops for record players size 12 x 9 1/2 x 3 1/4 \$1.50.

50 / Ohm pots ideal for ext. speakers etc 50c.

Miniature transistor and driver speaker transformers \$1 pair

Mixed tagstrips 60c dozen

30 mixed pots including ganged and concentric. \$5

Hookup wire, 30 mixed lengths & colours \$1

250 mixed screws, BA, Whit, self tappers, bolts nuts etc. \$1 bag, 25c post

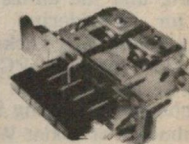
Portable 4 speed record player 240 volts all transistor \$19.50. Pack and post \$1, interstate \$1.50.



SUIT HOMODYNE TUNER

Car Radio Push Button Tuner \$4.50

Pack & Post 55c. Interstate 85c.



New range of small encoded keyboards

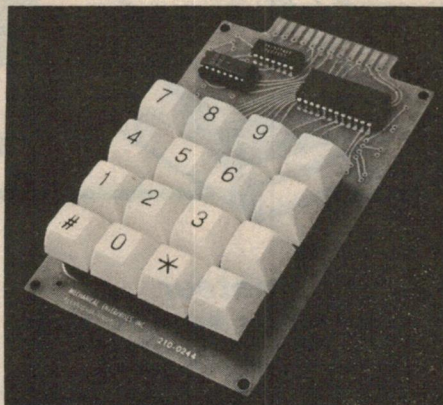
Mechanical Enterprises have released a new family of 15 small encoded keyboards for use in data communications, control devices, and other applications requiring boards with 10, 12, or 16 keys. Each keyboard is encoded with the Harris HD-1065 keyboard encoder, which features a 4-bit parallel output and 2-key rollover. All keyboard outputs are bounce-free and TTL compatible. The keyboards are factory coded in BCD, but can be altered in the field to make coding changes.

The new keyboards are available with one of three basic Mechanical Enterprises' switches, as follows:

- LM Gold V-Bar Switches — low profile switches with close mounting centres for hand-held keyboards;

- LFW Gold V-Bar Switches — full-stroke, mechanical spring-on-spring switches available in a pushbutton version or with double-shot moulded keytops (as illustrated in the photograph);

- Mercutron Switches — full-stroke,



mercury-filled tube switches, featuring sealed contacts.

For further information, contact General Electronic Services Pty Ltd, 114 Alexander St, Crows Nest, NSW 2065.

greater than 1.2:1 up to 250MHz; capacitance — less than 5pF; current rating — 2A; insulation resistance — greater than 30,000 Megohms; contact resistance — less than 2 milliohms; breakdown voltage — greater than 4kV.

An extensive range of attenuators is also available, and these have attenuation characteristics ranging from 3dB to 36dB.

For further information, contact McMurdo (Australia) Pty Ltd, 17-21 Carinish Road, Clayton, Victoria 3168. Also at 219 Blaxland Road, Ryde, NSW 2112.

Electronic equipment stolen from Aegis

Aegis Pty Ltd advises that their factory premises in Thornbury were entered by thieves on the night of Thursday, May 30, and the following items of equipment were stolen —

Hewlett Packard HP35 Calculator, Serial No. 1302S40308; Tektronix Model 422 Double Beam Oscilloscope, Serial No. 140; Sugden Distortion Measuring Unit Type SC453, Serial No. 2128; Sugden Audio Oscillator Type S1453, Serial No. 2059; Odhner Adding & Calculating Machine, Model MX11C/9, Serial No. 21489.

Would anyone knowing anything of the whereabouts of any of the above instruments kindly advise Aegis Pty Ltd, or the Northcote (Victoria) CIB.

sockets for TV, radio, electronic and instrument applications. Included in the new range are in-line, chassis mounting and printed wiring board sockets to suit a wide range of applications. Both polished aluminium and insulated free plugs are available for 1/4-inch and 5/32-inch cable entry.

A reinforcing circlip on the socket provides both strength and resilience, with excellent plug to socket contact. All inline plugs and sockets are equipped with an insulation clamp to ensure reliability of cable to socket connections.

Specifications of the new range are as follows: impedance — 65-75 ohms; VSWR —

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CB NOVICE BAND ANTENNAE. BUY DIRECT FROM MANUFACTURER. SPECIAL INTRODUCTORY OFFER

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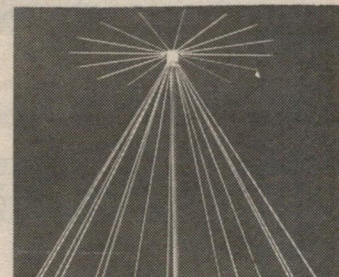
Model HCM1
Supplied complete
with 6ft. coax & UHF
connector 30° cowl
mounting base.

Model HWM2 fitted
with UHF connector
for direct connection.

Plastic covering on both antennae with built-in inhibitor against ultra violet radiation for years of service without deterioration.

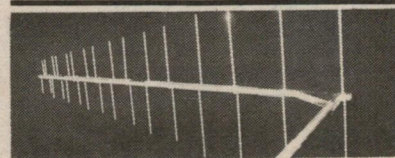
CB novice band 4 Element Beam Antenna designed for field use, dismantles into approx. 9ft. lengths. 16 gauge solid tubing. Exact tuning chart and stubs supplied. Quick & easy to assemble gamma matched **\$45.75 incl s / tax.** 50ohm imp. Shipping weight 12lbs.

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Log Periodic Antenna

Equal to 3 element beam over 140mhz to 450mhz Horizontal Pol 50ohm.

MODEL LP4 **\$46.85 incl. S / Tax.** SHIPPING WEIGHT 7LB.

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SCIENTIST

The Chemistry Division of the Department of Scientific and Industrial Research, Lower Hutt, New Zealand, has a vacancy for an Electronics Engineer.

DUTIES:

Extension of advanced Electronic/optical/metallurgical instrumental techniques, and research into obtaining optimum performance from analytical and control instrumentation. Installation, maintenance and servicing of a wide range of instruments.

QUALIFICATIONS:

Honours degree in Electronic Engineering, Applied Physics or Physical chemistry. Good knowledge of laboratory instrumentation, and experience in the use or design of electronic and logical circuitry and servo systems desirable.

SALARY:

Up to \$NZ10,232 per annum dependent on qualifications and experience.

APPLICATIONS:

Applicants should quote Vacancy No. 3311 and forward applications to the New Zealand High Commission, Commonwealth Avenue, Canberra, A.C.T. 2600, by Friday, September 6, 1974.

LARGEST RANGE IN AUSTRALIA OF ELECTRONIC AND RADIO BOOKS

Mail orders available, prompt attention.
See below for this month's new publications.

R.C.A. COS / MOS Integrated Circuits Manual	\$3.75
R.C.A. Solid-State Hobby Circuits Manual	\$3.00
R.C.A. Receiving Tube Manual	\$3.75
R.C.A. Solid-State Power Circuits	\$7.40

JUST IN - 1974.

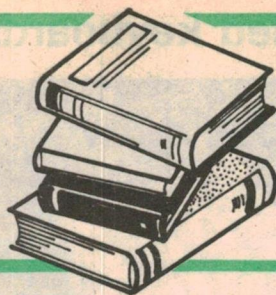
The Radio Amateur's Handbook. 1974	\$6.95
Amateur Radio Techniques. By P. Hawker, R.S.G.B. Publication	\$5.60
Radio Handbook. New 19th Edition, by W. I. Orr	\$14.30
How to Listen to the World. New 8th Edition	\$4.95

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Books & Literature

For the amateur

TEST EQUIPMENT FOR THE RADIO AMATEUR by H. L. Gibson, CEng, MIEE, G8CGA. Published by the Radio Society of Great Britain, London, 1974. Circuits, diagrams, photos and explanatory text. Hard covers, 136pp, 10 x 7in.

RSGB publications have an excellent reputation, and this new book by H. L. Gibson would certainly appear to uphold the tradition. While some of the designs have presumably been published earlier, much of the material has not, so that the book becomes a very desirable reference manual for the amateur who wants to build up his test resources — in terms both of understanding and equipment.

The opening chapter on indicating instruments is at a quite elementary level and is presumably intended for study by prospective recruits to the amateur ranks. Chapter 2 on "Electronics Instruments" gets progressively deeper, beginning with a simple valve voltmeter, then its solid state counterpart, and on to a complete electronic multimeter and its peripherals. The text and circuits could be treated as study material or as the basis for a whole series of constructional projects.

Dip oscillators enjoy quite extensive treatment, as also does the subject of frequency measurement, which begins with simple crystal markers and ends up with a digital frequency meter.

There are chapters on the measurement of RF power, noise, and aerials and transmission line characteristics.

These are followed by a section on instruments for measuring components, signal sources and attenuators, and finally oscilloscopes and swept frequency techniques.

Reference data and an index round out a book which should be able to keep the industrious amateur mentally busy for quite a while!

Our review copy came direct from the RSGB but the book should be available in due course through local technical booksellers. (W.N.W.)

Digital manual

EXPERIMENTING WITH DIGITAL CIRCUITS, by Jack Cazes, PhD. Published by EL Instruments, Inc, Derby, Conn. About 250pp, loose bound in clip folder. Many diagrams. Price in Australia \$7.00 plus postage where necessary.

When I wrote the article describing EL Instruments' "Digi-Designer" unit in the March issue, I noted that it was essentially a complete miniature logic laboratory and suggested that it would be very suitable for use as a logic trainer in schools and

colleges. Fairly obviously, they too had realised how suitable it would be for this sort of application, and they have already produced this laboratory manual for use with the unit. The author is Dr Jack Cazes, who will no doubt be familiar to some readers as a regular contributor to some of the US magazines.

In his preface, Cazes notes that the manual is not intended to replace existing texts on digital logic and circuitry, but rather to supplement them. In fact he gives a list of suggested texts, and my only fault

with the book is that it does not cover counters and shift registers, and even things like scalars and decoders. What's more, it should all have been quite easy going, thanks to author Cazes' writing and planning.

At the price of \$7.00, there is no doubt that this manual is exceptional value and an invaluable companion to the Digi Designer.

The review copy came from General Electronic Services, who are the Australian agents for EL Instruments, but copies of the manual are available through any wholesaler. (J.R.)

Mainly for boffins

TRANSIT-TIME EFFECTS IN UNIPOLAR SOLID STATE DEVICES, by Dan Dascalu, PhD. Published by Abacus Press, Tunbridge Wells, Kent, 1974. Hard covers, 175 x 245mm, 395pp, with diagrams. Price in UK £11.50.

A rather specialised book, presenting a theory embracing transit-time effects in unipolar one-dimensional semiconductor devices such as FETs, space-charge-limited current devices, and Gunn devices. It is written primarily for engineers and applied physicists with interests in the solid state and semiconductors. The author is a researcher currently working in the Department of Electronics and Telecommunications at the Polytechnical Institute of Bucharest, Romania, and the book is based on this research.

It is divided into 14 chapters, grouped into three sections. Those in the first section

introduce the mechanisms of carrier injection and transport in crystalline solids and the metal-oxide semiconductor system. Those in the second section discuss linear theory, small signal operation, stability and noise. Finally in the third section non-linear theory is treated, together with transient and large-signal behaviour.

The treatment is highly mathematical, and far too deep for this reviewer. However it would appear to be very well written, and should be of considerable interest to anyone involved or intending to become involved in research into unipolar devices.

The review copy came from the publisher direct, and no information was given regarding local price or availability. (J.R.)

Biggest yet . . .

ELECTRONICS VOLUME III, A BIBLIOGRAPHICAL GUIDE, by L. Corbett. Published by Macdonald & Co, UK, 1973. Hard covers, 180 x 240mm, 799pp. Recommended retail price \$73.45.

Retailing for around \$73.00, this book ranks as the most expensive we have ever reviewed. However, before reaching for the "hip pocket nerve" tranquillisers, it may be as well to point out that it is intended mainly for libraries, research institutions and the like, and that the contents are rather specialised in that it attempts to list all the major works in electronics literature during the period 1965 — 1968.

The enormous growth in recorded information in recent years has added greatly to the difficulties of the scientist in keeping abreast of the work being done in his own and related fields, and also to the problems of literature searching. Nowhere are these problems more pronounced than in the field of electronics, and it is as a contribution to easing the problems of literature searching, which is both time consuming and costly, that this volume is intended.

The book begins by giving a list of all periodicals cited in the text, together with a list of the abbreviations used. This is followed by some seventy sections, each devoted to a specialised field of electronics, in which a list of all the major works in that field between 1965 and 1968 is presented. Information pertaining to each entry is presented in three columns: column 1 lists the bibliographical details of the work cited, column 2 lists the total number of references cited, and column 3 gives a brief summary of the contents.

The concluding chapters contain comprehensive author and subject indices. These not only contain information relevant to this volume, but also to the two previous volumes, Volumes 1 & 2, which cover the periods from 1945 — 1959 and 1959 — 1964 respectively.

In summary, this book should be invaluable to companies, research institutions, and student libraries where a great deal of information research is required. The time saved in searching out the relevant subject titles would justify its undeniably high price within a very short period of time. The book does, however, have one serious shortcoming in that, apart from the author and subject indices, it only covers the period from 1965 to 1968. For the individual, it is too expensive, and on a value for money basis would be hard to justify.

The review copy came from Novalit Pty Ltd, Royal Place, off 210 Swan Street, Richmond, Victoria 3121. (G.S.)

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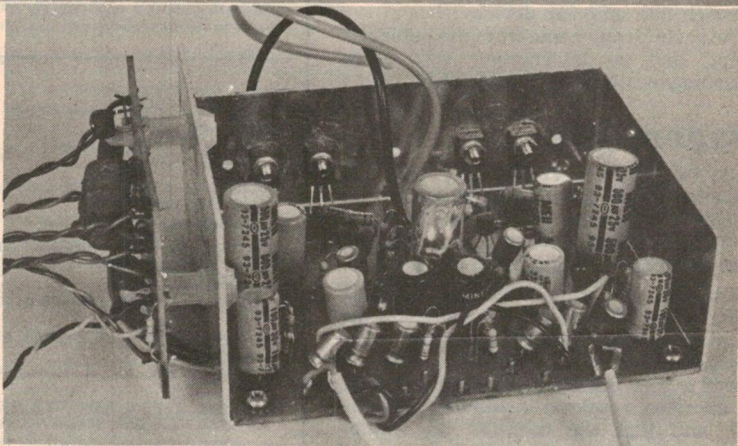


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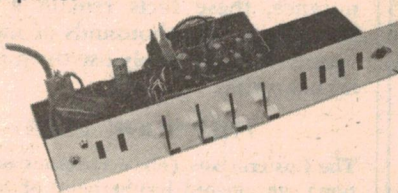
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The Amateur Bands

by Pierce Healy, VK2APQ



Remembrance Day Contest

Comments on the WIA Remembrance Day Contest, and an international competition for young people sponsored by the ITU are features of this month's notes.

A contest which has no outright winner is unusual, but the Remembrance Day Contest sponsored by the Wireless Institute of Australia, is the most popular amateur radio contest among Australian operators. The contest was inaugurated to perpetuate the memory of Australian amateurs who paid the supreme sacrifice in World War II.

A perpetual trophy is awarded annually for competition between divisions of the WIA. The trophy is inscribed with the names of those amateurs who made the supreme sacrifice and so perpetuates their memory among amateurs throughout Australia. More recently, New Zealand amateurs have participated in the contest.

The name of the winning division is inscribed on the trophy and the division receives a suitably inscribed certificate.

Objects: Amateurs in each VK call area, including Australian mandated territories, Australian Antarctica, and Papua / New Guinea will endeavour to contact amateurs in other VK and ZL call areas, on all bands. Intra-state scoring contacts are permitted on VHF / UHF bands above 52MHz. Repeaters may not be used.

Contest date: 0800 hours GMT Saturday, 17th August, 1974, to 0759 hours GMT Sunday, 18th August, 1974.

All amateur stations are requested to observe 15 minutes silence before the commencement of the contest on Saturday afternoon. An appropriate broadcast will be relayed from all divisional stations during that period.

Rules: Due to the disruption to postal services at the time these notes were being compiled, details of any changes to rules or scoring table had not come to hand. It is thought that, in general, the rules will be the same but some alterations may be necessary, particularly the scoring table. This would be due to the fact that the Australian Capital Territory Division came into being at the WIA federal convention, 1974, and that the Papua / New Guinea call sign has been changed to P2.

Some of the main points in the rules unlikely to be changed are:

- There are four sections:—
 - Transmitting — phone
 - Transmitting — CW
 - Transmitting — open
 - Receiving — open
- All Australian amateurs may enter whether fixed, portable, or mobile. Wia members and non-members are eligible for awards.
- All amateur bands may be used and cross mode

operation is permitted. Cross-band operation is not permitted.

4. Amateurs may operate on both phone and CW during the contest, IE phone / phone, CW / CW, or phone / CW. However, only one entry may be submitted for sections (a) to (c) in Rule 1.

An open log will be one in which points are claimed for both phone and CW. (CW contacts count double.)

Cyphers: Before points may be claimed serial numbers must be exchanged and acknowledged. The serial number of five or six figures will be made up of the RS (telphony) or RST (CW) reports plus three figures that will increase in value by one for each successive contact. If any contestant reaches 999 he will start again with 001.

Receiving Section:

Open to all short-wave listeners in Australia and New Zealand, but no active transmitting station may enter.

Contest times and logging are as for transmitting. It is not permissible to log a station within the same call area in which the receiving station is located except on bands 52MHz and above.

Entries must be set out using one side of paper only in the standard log sheet format. Entries must be clearly marked "Remembrance Day Contest 1974" on the envelope, and must reach the Federal Contest Manager WIA, Box 679, Post Office, East Melbourne, Victoria, 3002, in time for opening on Friday, September 20, 1974. Early entries will be appreciated.

LOCAL AND OVERSEAS NEWS

INTERNATIONAL COMPETITION

The ITU has announced an international competition "Youth in the Electronic Age," as part of the telecommunication exhibition TELCOM 75.

The competition should be of interest to those studying any facet of electronics. This includes members of the WIA Youth Radio Club Scheme. In fact the media that competitors can use suggests that a high degree of technical knowledge is not essential.

As Australia is a member of the ITU, represented through the PMG's Department, it is suggested that intending Australian participants direct their inquiries to that department.

Details as received from the ITU are:

Purpose:

On the occasion of the second world telecommunication exhibition, TELCOM 75, in Geneva from the 2nd to 8th October, 1975 a "Youth in the Electronic

Age" competition will be held for young people of 8 to 18 years of age in order to make them more aware of:—the intensive and ever-growing use of telecommunications in the world today;—the part that such techniques play in economic and social development;—the need for qualified technicians.

Conditions:

The competition is open to young people who have reached the age of 8 years by 1st January, 1974 and who have not yet reached the age of 18 years by that date.

Category:

Entrants will be divided into two age groups;

Group A — 8 to 12 years

Group B — 13 to 18 years.

Entries may be individual or collective.

Subjects:

Among the subjects that might be selected are — telecommunications in the future — how it is thought they will develop, what their effect will be on the family, on mass communication, on economic and social development and on understanding among people.

Any other subject relevant to telecommunications will be accepted.

Media to be used:

The written word, pictures (photographs, films, drawings, animated cartoons), sound, scale models, sculpture.

Information sources:

Information from any source may be used, in particular that disseminated during TELCOM 75. Information on the ITU and its publications and on the exhibition may be obtained on request through the authority organising the competition in the country concerned.

Selection of entries:

A national jury will be appointed in each country participating in the competition to select the ten best entries in each age group.

Date for submission of entries selected on the national level:

The entries selected shall be sent by the national authority, together with a written translation into one of the working languages of the ITU, to the headquarters of the ITU by the 30th June, 1975 under the following cover:

Public Relations Division,

Competition "Youth in the Electronic Age."

Jury:

An international jury will be set up in Geneva, consisting of specialists in youth affairs, teachers and telecommunication experts.

Prizes:

A list of prizes will be published in Geneva on the 17th May, 1975, the 7th World Telecommunication Day.

Announcement of results:

Results will be announced during the second World Telecommunication Exhibition, TELCOM 75, to be held in Geneva on the 2nd to 8th of October, 1975.

AMATEUR RADIO IN USSR

The following article is from the Westlakes Radio Club newsletter, which gives some interesting facts about amateur radio in the USSR. It may explain the large number of SWL QSL cards that most HF operators receive. "If you think getting the licence in Australia is difficult, then compare it with the requirements in the USSR.

"It has been stated that the Soviet Union has some of the world's most skilled operators in amateur radio. Credit for this goes partly to the Soviet Government, which sets high standards and offers surplus equipment, technical information, and attractive awards as incentives.

VK SCORING TABLE

	To	VK0	1	2	3	4	5	6	7	8	9/1	9/2	P2	ZL1	2	3	4	5
From VK0	-	6	6	6	6	6	6	-	6	6	6	6	6	2	2	3	4	1
" VK1	6	-	1	1	2	3	5	4	6	5	1	5	1	2	3	4	6	
" VK2	6	3	-	1	2	3	5	4	6	5	-	5	1	2	3	4	6	
" VK3	6	4	1	-	2	1	4	3	6	5	4	5	2	2	3	4	6	
" VK4	6	3	1	2	-	3	6	5	4	3	3	-	3	3	4	6		
" VK5	6	5	2	1	3	-	4	3	-	6	6	6	4	4	4	5	6	
" VK6	6	6	2	1	4	2	-	3	5	-	6	6	6	4	4	5	6	
" VK7	-	5	1	1	3	2	5	-	5	6	6	6	6	2	2	3	4	6
" VK8	6	5	1	1	2	-	6	4	-	3	4	3	4	4	6	6		
" VK9/1	6	5	1	2	3	4	-	6	1	-	6	3	5	5	6	6	6	
" VK9/2	6	1	-	2	2	4	5	4	4	6	-	3	1	2	3	4	6	
" P2	6	5	1	2	-	4	5	6	1	3	3	-	5	5	6	6	6	

ZL SCORING TABLE

	To	VK0	1	2	3	4	5	6	7	8	9/1	9/2	P2
From ZL1	6	1	1	1	2	2	5	3	5	6	5	6	
" ZL2	6	1	1	1	2	2	5	3	5	6	5	6	
" ZL3	6	3	3	3	4	4	6	4	6	6	5	6	
" ZL4	6	4	4	4	5	5	6	5	6	6	5	6	
" ZL5	1	6	6	6	6	6	6	6	6	6	6	6	

VK9 / 1 indicates VK9 stations in the Indian Ocean area. VK9 / 2 the VK9 stations in the Pacific Ocean area. P2 indicates Papua / new Guinea.

"Today the Soviet Union's amateurs number over 15,000, of which 10pc are female operators. To become an amateur in the Soviet Union, the procedure is:

- Complete a basic electronics course.
- Join a radio club and take a test which licences the applicant to listen on the amateur bands and log stations. He must be able to send and receive Morse at 10wpm.
- After at least six months experience as an SWL, the applicant is then able to take the third-class test.
- The third-class test consists of a more difficult exam and a 12wpm Morse test. The schematic of a 10W transmitter must be drawn, and he must explain what kind of antenna would be used and how it would be tuned. The third-class certificate permits 10 watts on 3.5MHz to 3.65MHz and 7.0MHz to 7.1MHz CW, and

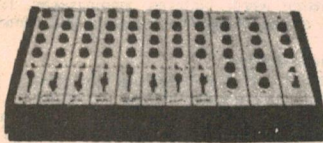
Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent direct to Pierce Healy at 69 Taylor Street, Bankstown 2200.

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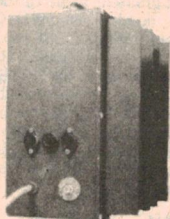


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6. The first class exam requires the operator to send and receive Morse code at 18wpm, design transmitter and receiver circuits, build and also troubleshoot advanced transmitters and receivers. They can operate 200 watts CW or phone on all bands available to second class operators. They can send and receive QSL cards only via:— CRC, Box 88, Moscow."

NEW ZEALAND VISIT

Early this year Gregor Cox, VK3ZCG and his wife visited New Zealand. Here are some comments from Gregor on the trip, in particular those relating to reciprocal licensing and VHF repeaters.

A New Zealand licence is issued upon the production of an Australian operators' certificate and current licence, an application form on an appropriate form, and a fee of \$3.00. To save time, the intending visitor should write for an application form to:— Chief Radio Inspector, 150 Hobson Street, Auckland, New Zealand. Return the completed form and fee and usually the licence is issued within a few days.

All holders of Australian limited licences are issued with a New Zealand "T" licence. This does not allow operation below 144MHz. Unless an Australian full licence was issued when the requirement was a Morse code test of 14 words per minute, only the "T" class licence will be issued.

For use on the trip Gregor took along a modified STC 131 Carphone, an AC power supply for portable operation and crystals for operation in the following New Zealand FM repeater and simplex channels.

Repeater frequencies:

Input	Output
146.30MHz	145.60MHz
146.35MHz	145.65MHz
146.40MHz	145.70MHz
146.45MHz	145.75MHz

Simplex frequency — 146.00MHz.

While operating portable at Huntly, about 96 kilometres south of Auckland, using a ground plane antenna three metres above ground, contacts were made with twenty separate stations through the Auckland repeater. That repeater uses the first set of frequencies and runs 15 watts into a vertical dipole. By moving the ground plane antenna and Huntly a few feet, it was possible to work through a repeater in the Waikato area some 48 kilometres away, which uses the second set of frequencies. It runs 15 watts but uses collinear dipoles as the antenna system.

During a tour around the southern section of the North Island it was planned to use a repeater at Palmerston North, a five eighth antenna being mounted on the car. However a slight mishap

prevented any contacts being made. Feeding coaxial cable through the car door does not always work, particularly when the door chops the cable in two.

Later, about 274 kilometres north of Auckland in a different car, operation was very satisfactory. The repeater at Whangarei uses the second set of frequencies and runs 6 watts. Only two contacts were made through that installation as most of the operators are away during the day. During the visit 33 stations were worked. A part of the time was spent near Kaitiaki which is well out of range of any repeater. However, a few days before returning home contact was made with a ZL2 from Nelson in the South Island, who was getting through the Auckland repeater during a brief period of temperature inversion.

All the repeaters mentioned are FM. There are still a few AM systems in the South Island, but these are being phased out. It was learned in Auckland that there is interest in SSB on 144.1MHz. and contact with Australian stations would be welcome.

Summing up, Gregor said; visitors are made most welcome on the air and by personal contact. There are many meetings that can be attended.

Apart from the radio aspect, the country is very scenic. The roads he saw were very good, although sometimes slow because of the many curves. There is an absolute speed limit of 80 kilometres per hour, together with the closure of service stations over the weekend; a government economic measure. It has been indicated that all weekend travel during the winter will be barred, apart from road users with permits. So spare a thought for our friends across the Tasman who rely on us for their fuel supplies.

Duty free shopping on a range of items is available in Auckland city as well as at the airport. Articles purchased are not made available immediately but are placed on the ship or plane and made available at your destination. Authority to purchase is recognised by production of travel ticket and Australian currency.

WIA YOUTH RADIO SCHEME

The State supervisors' conference of the WIA Youth Radio Club Scheme (YRCS) is to be held at the Maitland Radio Club on the weekend 31st August, 1974. It is expected that a lengthy agenda, covering all facets of the YRCS, will be dealt with.

The official YRCS publication is "Zero-Beat". This is issued every two months, starting each year in February, and contains information on YRCS activities, news from clubs, short-wave listening notes, and technical articles and projects suitable for the various YRCS study levels.

The subscription rate for the publication is 60 cents, including postage, per year, paid in advance. All subscription correspondence should be addressed to the editor, A. W. Grove, 6 Trueman Avenue, Salisbury East, Sth Aust 5109

Correspondence Section

The correspondence section of the YRCS is for those who are not able to belong to a school club or in areas where no radio club operates. Members of this section are allocated to group leaders who follow their progress through the course.

Rare opportunity for calculator technicians

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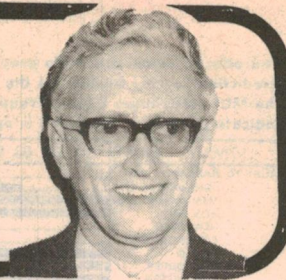
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61-3281

BRISBANE
CANBERRA

52-7333
95-2144

Shortwave Scene

by Arthur Cushen, MBE



Radio Canada International has recently announced a new tentative operating schedule. Due to come into operation next month, the new schedule includes the use of the three new relay stations located at Moosbrunn, Malta, and Kigali.

In recent months, programs from Radio Canada have been relayed to Europe over the BBC transmitters at Daventry and over the Trans-Europe transmitters at Sines, Portugal. From September 1, Radio Canada programs will be carried by additional relay stations in order to provide better reception in Europe and Africa, and plans are under way for the programs to be re-broadcast by Moosbrunn, Austria; Deutsche Welle; Malta; and from the Deutsche Welle relay base at Kigali, Rwanda.

The relays from Malta are scheduled on 6110kHz, 1800-1900GMT; 7240, 0530-0730; 9505, 1800-1900; 9710, 0530-0730.

The relays from Kigali are scheduled for later announcement as are the programs to be relayed from Moosbrunn, Austria. The power of the relays at Malta and Sines is 250kW and at Daventry, 100kW, while the Sackville transmitters in Canada, which originate the broadcast, also use 250kW.

LATIN AMERICAN NEWS

BOLIVIA: Radio Nacional Huanuni, located at Huanuni in the province of Oruro, has been heard on 5965kHz with good signals during the afternoons. Reception in New Zealand has been possible from around 0300GMT and the station gives frequent identification announcements. At 0345GMT, the BBC service in Russian opens on the frequency and blocks out further reception.

ECUADOR: Many listeners have been puzzled by the Ecuadorian station which has been operating all night on 4800kHz, and is best heard around 0800GMT. Jack Buckley of Coogee, NSW, has been hearing this signal, while it has also been observed in New Zealand. The station is Radio Popular Independiente, Cuenca. In New Zealand, Bryan Clark of Wellington and Chris Davis of Featherston have heard this station on a second frequency of 4610kHz.

PERU: Radio Chinchachoya has made a frequency change, and we have been hearing this station closing at 0545GMT on 4860kHz. The station previously operated on 4845kHz, has the call sign OBZAZ, and is located at Junin.

ARGENTINA: Two good signals have been heard at 0930GMT, and these are Radio Nacional Buenos Aires on 6060kHz and Radio Nacional Mendoza, Argentina on 6180kHz.

BRAZIL: One of the low frequency Brazilians, ZYE54 on 3345kHz, has been heard by Chris Davis of Featherston, NZ, around 0845GMT. This station has the slogan "Radio Alvorada de Londrina" and has been providing good reception considering that transmitter power is only 1kW.

NEW ECUADORIAN SIGNAL

A new station in Loga, Ecuador, has been heard on 5060kHz, closing at 0515GMT. The station uses the slogan "Radio Nacional Progreso," and has popular Latin American music with station announcements every ten minutes. During the closing announcement, reference is made to the broadcast only being available on short-wave, and a full address is given during this announcement in Spanish. Radio Nacional Progreso uses the march "Anchors Away" as its

Further details on other stations, and information on what is being heard by readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT, add 8 hours for WAST, 10 hours for EAST and 12 hours for NZT.

closing number and does not play the Ecuadorian national anthem when transmission concludes for the day. At the present time several other stations in Loga have been heard on the 60 metre band, with the best signal on 4820kHz from Radio Luz.

RECENT VERIFICATIONS

COLOMBIA: Radio Super at Medellin, which was recently reported operating all night on 5950kHz, has now confirmed reception and gives the mailing address as: Radio Super, Apartado 3399, Medellin. **AFFAR AND ISSAS:** Radio Djubouti, which operates on 4780kHz, has verified Michael Willis of Melbourne (according to ADXN) with a post card showing a photo of the transmitter building. The country, formerly French Somaliland, confirmed reception in six weeks following a report sent in French.

SIERRA LEONE: Freetown, which has been using 5980kHz and is heard around 0800GMT, has confirmed reception of a report sent to them by Geoff Cosier, according to ADXN. The confirmation was in the form of a letter from the Engineer in Charge, E. Pele Roberts, and this was received in six weeks.

NEW CANADIAN FREQUENCIES

Four new frequencies currently in use with Radio Canada International have recently been observed, and these are well outside the recognised shortwave bands. The station is also carrying out transmissions on other channels on a test basis, and these have been noted.

In the transmission to Europe from 0558-0630GMT two new frequencies of 9480 and 5925kHz are now in use, replacing the former channels of 9655 and 6140kHz. These new out-of-band frequencies both provide excellent reception during the transmission in English and French. The power on 9480kHz is 250kW and on 5925kHz is 125kW.

A broadcast in English from 2158-2230GMT is now heard on 11990 and 15092kHz and these two frequencies replace 11855 and 15325kHz. The power on both frequencies is 250kW and the transmission is beamed to Europe.

ENGLISH FROM MOSCOW

Radio Moscow, in its service to Australia and New Zealand, uses frequencies on both medium and short-wave for transmissions via the Siberian relay station. The English programs are now heard on the following schedule:

GMT	kHz
1100-1200	629, 1250, 5960, 9750, 12060.
1200-1230	9750, 12060.
1230-1300	629, 1250, 5960, 9750, 12060

Moscow Mailbag, in which letters from listeners are answered, is broadcast on Sunday at 1215GMT and on Saturday at 1115GMT.

ESSENTIALS FOR REPORTING RECEPTION

There seems to be a concerted effort by many listeners to try to improve the quality and informative value of their reception reports to radio stations. This has resulted in some excellent articles on the topic of report writing appearing in various publications.

In a recent issue of the magazine of the International Radio Club of America, the main requirements for reception reports were listed. These requirements are as follows:

- Mail the report as soon as possible after reception;

- The report should be accurate and written in a courteous manner, and should provide information that applies only to that station;
 - Avoid using terms which the radio station may be unfamiliar with;
 - Make every effort to include a report on between 15 and 20 minutes of the program material;
 - Give a good summary of signal strength and conditions;
- Include the return postage with the report.

MEDIUM WAVE NEWS

HAWAII: Station KPUA at Hilo is to make a frequency change to 670kHz according to "Broadcasting." Previously, it had been suggested that the frequency would be 620kHz, but KPUA has now applied for a construction permit to operate on 670kHz with 5kW. **GUAM:** Guam Broadcasting Company has applied for a licence to operate on 720kHz with 10kW. The application from this new company is now under consideration and, according to "Broadcasting," their address is: Box 2890, Agaña, Guam 96910. The present medium-wave station, KUAM, in Guam is on 610kHz, uses 10kW, and is frequently heard in this area during our early mornings.

AUSTRALIA: The new ABC repeater station, 6XM at Exmouth, West Australia, was officially opened on April 25 according to Paul Aronsen of Invercargill, NZ, who received a verification from the station. The power is 2,500W, and the station employs two transmitters which are time operated.

LISTENING BRIEFS AFRICA

EGYPT: The Voice of Africa, Cairo, has been heard during test transmissions on 15210kHz. According to the announcements, they broadcast from 1900-2200GMT and request reports to: Voice of Africa, PO Box 566, Cairo, Arab Republic, Egypt.

SOUTH AFRICA: The Springbok Radio has been heard on a new frequency of 4810kHz by several New Zealand listeners, according to the NZ DX Times. The reception has been best around 0500GMT when news and weather is broadcast. There is some interference on the frequency before this time from the Voice of Galapagos which is now using 4810kHz and a radiated power of 5kW.

SEYCHELLES: The Far East Broadcasting Association has been heard at 0550GMT with an interval signal on 15270kHz. At 0600 the sign-on announcement indicates that the transmission is beamed to India and Pakistan. The program includes popular music to 0630GMT, followed by a program for children. At 0700GMT the BBC World News is relayed.

TANZANIA: According to the Japanese Shortwave Club, Radio Tanzania has extended its schedule to sign-off at 2015GMT. Portuguese has been noted at 1900GMT and English at 1930GMT to sign-off, though this schedule does not seem to follow the same pattern daily. Early reception of the signed at 1800GMT also included a news bulletin in English on 15435kHz.

ASIA

SRI LANKA: According to the DX Club of India, Radio Sri Lanka is now operating in English with the All Asian Service of the Sri Lanka Broadcasting Corporation from 0030-0430GMT on 15120, 11725, 6075kHz and from 1230-1730 on 15120, 11725, 7190kHz. BBC News is at 0200 and 1600GMT and News from Sri Lanka at 1300GMT.

LAOS: A new station is reported in "DX Corner Belgium" as operating on 7385 and 840kHz. The transmission, which is broadcast in Lao, is from 2300-0200 and 0500-1400GMT and in Vietnamese from 1430-1500GMT.

TAIWAN: The American Forces Network in Taiwan continues to be heard around 1700GMT on 3995kHz at good strength. The broadcast is also carried on 7215kHz, as well as on medium-wave. The station has recently confirmed our reception with a new card, and the address is now given as Department of the Navy, AFTN, Box 25, APO San Francisco, 96265.

INDONESIA: RRI Jayapura has been heard opening the morning transmission on 15345kHz at 2200GMT. From 2158GMT the station has a series of chimes and then opens with a march. Following station identification in Indonesian, the morning program of bright music is preceded by the sound of a siren. Another frequency used by the station, 6070kHz, is well received at 0800GMT when opening with the evening program.

Radio Republic Indonesia at Jayapura has also been heard by Craig Tyson, Wembley, WA, on 7165kHz. This channel opens at 0755GMT with the station interval signal, followed by full announcements at 0800GMT, and carries the same program as on 6070kHz. Radio Republic Indonesia Ambon has also been heard signing on at 0800GMT with full station identification in Indonesian on 7139kHz.



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\$55.

P&P \$2.40

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This power packed compact hand operated hoist lifts or pulls up to 500lb. dead weight. Rustproof • indestructible • fitted with 3" nylon rope will lift over 8". Weighs only 1lb. 1001 uses for house owner, motorist, boat and caravan owner, etc. Bargain. U.S. \$7.95.

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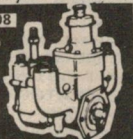
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British Army issue, absolutely brand new. Accurate to under one degree. Stout hinged brass case, external diameter 2 1/4 inches. Prism Holder with focussing arrangement. Compass interior contains Mother-of-Pearl Azimuth, divided to single degrees, mounted with sapphire centre floating on liquid on an iridium point. Transparent Rotary Scale on case divided to every 5 degrees and figured every 1 degree, can be clamped in any position, luminised for night use. Its steadiness makes it a perfect compass for geologists or surveyors or for taking bearings from boats, cars, aircraft, etc. Units are brand new and fully checked by instrument maker before despatch. Sells at a fraction of Govt cost. We have sold these to nearly every Govt. dept., shire Councils, mining coys., surveying coys., etc. in Australia. P&P 75¢

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\$12.50

P&P \$1.50



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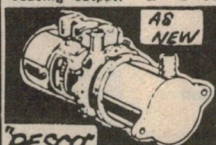
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AS NEW

3 months' guarantee

"PESCO" ELECTRIC PUMPS WITH MOTOR — \$35

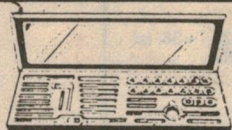
Famous American "PESCO" 2000 g.p.h. electric pumps with motor. Pumps all liquids, water, kero, petrol, diesel fuel, even salt water (ideal for boats). Lasting quality — sealed motor corrosion and explosion proof. Ball-bearing motor is for 24-32 Volt D.C. Works perfectly on 12V. Draws only 8 amps. is for continuous duty. Will shift 2000 g.p.h. at 30 p.s.i. 1800 g.p.h. at 6' head. On 24 Volt pump will lift 65' less on 12V. if primed with foot valve will suck 25' then lift 40' less on 12V. Pump has mounting base 1 1/4" inlet for hose, 1" outlet for nose. Pump will work on 12V.-24V.-32V. D.C. AS NEW. Cost U.S. Govt. over \$200 each. 1 1/2" ball foot valve. \$3.95.



PARVALUX geared motors

1/4 h.p. beautifully made, originally for computers. Two speed with two 1/2 shafts. Fully ball bearing CAPACITOR START. 1400 r.p.m. and thru gearbox 100 r.p.m. cont. duty. Size 12" x 5" complete with capacitors \$25. P&P \$3.50 Same as above but 30 r.p.m. 1/4 h.p., complete with capacitors. 2 speed 1400 r.p.m. and 30 r.p.m. cont. duty \$25

"Parvalux" England make some of the finest electric motors in the world and normally these would cost over \$85 each to buy. These "Parvalux" ball bearing motors are ideal for large turntables, B-B-Q spits, displays, etc



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Made by "Meccano" England. Input 15 volts AC. output 0 to 12 volts DC in fine smooth control. Has 8 speed control positions in both normal and reverse. Unit is a step resistance, rectifier controller for up to 2 amps. Also for reverse and has off pos. and pulse power switch for ultra slow running. Ideal for models etc. new in carton with instructions and guarantee. Worth \$9. P&P \$1.00

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Impedance about 2k ohm with sufficient output for valve or transistor equipment. Miniature size, fitted with rubber sucker which presses on to telephone in position giving maximum volume.



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Specifications:
 DC Volts: 0.25, 2.5, 10, 50, 250, 1000.
 AC Volts: 10, 50, 250, 500, 1000.
 DC Current: 50uA, 25mA, 250mA.
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 Decibels: -10, +22 (at AC / 10V) +20, +36 (at AC / 50V). Upper frequency limit 7KHz.
 Batteries: Two 1.5V dry cells.
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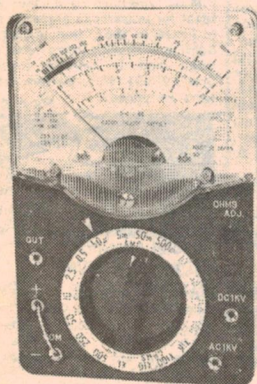
MODEL RH-80 \$22.00
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20,000 Ohms per volt DC.
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 DC Volts: 0.5, 2.5, 10, 50, 250, 500, 1000.
 AC Volts: 10, 50, 250, 500, 1000.
 DC Current: 50uA, 5mA, 50mA, 500mA.
 Resistance: 5K, 50K, 500K, 5M.
 Decibels: -10dB + 62dB.
 Accuracy: DC 3pc.
 AC 4 per cent (of full scale).
 Batteries: Two 1.5V dry cells, size AA, "Eveready" 915.

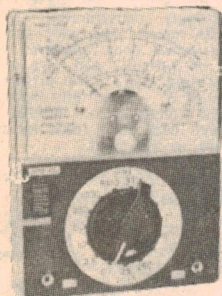
NEW RH (Radio House)
RANGE OF MULTIMETERS

MODEL RH-60 \$29.00 Packing & Postage \$1.00



50,000 Ohms per Volt DC.
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Specifications:
 DC Volts: 0.25, 2.5, 10, 50, 250, 500, 1000.
 AC Volts: 10, 50, 250, 500, 1000.
 DC Current: 25uA, 5mA, 50mA, 500mA.
 Resistance: 10K, 100K, 1M, 10M.
 Decibels: -10 + 62dB.
 Accuracy: DC ± 3 p.c., AC ± 4 p.c. (of full scale).
 Batteries: Two 1.5V dry cells.
 Overload protected.

"HANDYMAN" RH-150 \$14.75



CHECKED PACKED & POSTED \$15.50
 Pocket-size 3 1/4" x 4 1/2" x 1 1/4".
 Instruction sheet and circuit.

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 DC Volts: 2.5, 10, 50, 250, 1000.
 10,000 ohms per volt
 AC Volts: 10, 50, 250, 500, 1000.
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10 Bands, Solid State, Battery and 240 Mains Operation

Specifications: 14 Transistors, 6 Diodes, 1 Thermistor.

- Tuning Range and Intermediate Frequency**

Amplitude Modulation	(AM) 535-1600KHz	455KHz
Marine Band	(MB) 1.5-4.0MHz	455KHz
International Short Wave - 1	(SW1) 4-6MHz	455KHz
International Short Wave - 2	(SW2) 6-12MHz	455KHz
International Short Wave - 3	(SW3) 12-16MHz	455KHz
International Short Wave - 4	(SW4) 16-24MHz	455KHz
Frequency Modulation	(FM) 88-108MHz	10.7MHz
Aircraft	(VHF1) 108-140MHz	10.7MHz
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Weather Band	(WB) 162.40-162.55MHz	
- Antenna**
 Built-in Ferrite bar antenna for AM, MB.
 Built-in Telescopic antenna for SW1, SW2, SW3, SW4, FM, VHF1, VHF2, WB (swivel-type telescopic directional antenna).
- Output Power**
 Undistorted Power 600mW.
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- Dimension** 11" (H) x 13" (W) x 5" (D).
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\$135.00 Packing & Postage \$1.50.



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TEN-IN-ONE TESTER
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 Four ranges: 0-15, 0-50, 0-150 & 0-500V
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 Frequency range 1 - 140MHz
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 Frequency fixed at 455kHz, up to 700kHz adjustable.
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INFORMATION CENTRE

COURSES: I have been reading your publication for some time now and am writing for advice. I wish to become a serviceman. Is there a correspondence course available? What qualifications do I need to be a serviceman in Queensland? (K.B. Charters Towers, Qld).

② The Department of Technical Education operates courses in NSW for radio trades and television servicing, and we imagine there would be a similar body in Qld. They (or the Qld Department of Labour & Industry) should be able to tell you the qualifications needed. In all probability there are none — anybody can call himself a serviceman.

TV SOUND ADAPTOR: Has "Electronics Australia" ever described a hi-fi TV sound adaptor project or do you plan to do so in the future. I enclose a review of such a device from the magazine "Hi-Fi Sound" from about three years back. I have been told a unit of the type shown will be available in Australia shortly priced about \$100. (S.K., New Lambton Heights, NSW.)

② We have seen the review of the unit you refer to and in fact we spent some time developing a project along similar lines about two years ago. For various reasons, the project was discarded. We point out that such a unit is less necessary in Australia than in England, where the majority of TV sets do not have power transformers. In an Australian set you can make a signal connection straight from the ratio detector. With adjustment to minimise sync buzz and care to avoid earth loops, a sound signal is there for the taking.

LETTER FROM INDIA: I get "Electronics Australia" from one of my friends in Australia and find it very interesting. Hobbyists and students in Australia are quite lucky to have such a good electronics and hi-fi magazine. Could you give me the following information: What is the exchange rate from Indian rupees to Australian dollars? What is a log and linear potentiometer? Will wrong results occur if one is used in place of the other? Will you please publish my name in the magazine so I can get a pen friend? I am an engineering student, age 21. (D. Prasad Rad. 10-5-483 North Lallaguda Secunderabad, 500017 Andhra Pradesh, India.)

② Thank you for the compliment. As you can see your wish has been complied with. At the time of writing the Australian dollar is worth about 11 rupees but it fluctuates. Note, however that a subscription to E-A must be paid in Australian currency. Any bank should be able to arrange this for you. Logarithmic and linear potentiometers are explained by their names — one obeys a linear resistance-vs-rotation law, while the other follows a logarithmic curve. At a pinch, a log type can be used in place of a linear and vice versa, but the control of the circuit may not be optimum. Log pots are generally used where audio circuits are involved, as the response of the ear follows a logarithmic curve.

NOVICE LICENCE: As an ardent SWL, I am considering extending my activities to amateur radio. However, I doubt whether I possess either the technical proficiency or the code proficiency for an AOCIP. Could you tell me if the novice licence has evetuated and if so are details available?

I would also like to suggest periodic reviews of commercially available communications equipment of interest to the SWL and the amateur. (M.S., Mt. Colah, NSW).

② Details of the proposed novice licence are not yet available. However, you may sit for a limited licence without the Morse code requirements. Equipment reviews are a matter for the manufacturers and agents and if communications equipment is submitted to us we will gladly review it.

APRIL FOOL JOKE: I could hardly believe the advertisement on page 23 of the April issue of "Electronics Australia". Was that seemingly innocuous picture actually an IC amp? Surely, Dick Smith and his crew are kidding?

By the way, why are there so many classical record reviews in your magazine and so few pop reviews? (by classical I mean stuff like Mozart, Bacharach, etc). In

the last issue the ratio was 17:4. But here is a suggestion . . . why not cut down on record reviews all round and review them with more "depth".

Anyway, you've got a good magazine . . . keep it that way. (C.F., Lapstone, NSW).

② Dick Smith was kidding and you may have noticed the apology we placed in the Information pages of the May issue because the joke did not completely succeed.

As far as reviews are concerned, we doubt whether Mozart enthusiasts would consider Burt Bacharach's "Raindrops Keep Fallin' On My Head" a piece of classical music! On your suggestion of less reviews but more "depth", we have taken the present approach of as many brief reviews as possible because we believe this satisfies most of our readers. However, we appreciate your comments.

TUNERS: Some years ago, I built the Playmaster 123 Program Source with good results. Due to the design, AGC action is such that on the wide setting, the volume rises on each side of each station as it is tuned across. I partly overcame this by adding a 220 ohm resistor in the emitter of the AGC transistor (TR9). It also removed a small amount of distortion which was present. I recently built the Homodyne tuner described by Mr Herbert and I was impressed by its performance but selectivity was insufficient to separate all local stations. I then decided to convert the Playmaster 123 to Homodyne demodulation by using the LM1351 IC as used in your Superhet Homodyne tuner described in January, 1974. Although I had serious problems at first with distortion, I was able to reduce but not eliminate it by suitable reduction of coupling capacitors controlling signal input to the IC. What is the purpose of the two resistors associated with the IC? Also, is there any way of testing the IC other than by direct substitution? I am looking forward to the introduction of the FM broadcasting service. (R.V., Coogee, NSW.)

② Your method of dealing with the AGC performance is interesting. However, your mention of distortion prompts us to suspect that the AGC system was not

working correctly and this can be cured by adjusting the capacitor from the collector of TR6 to the base of TR7. A value of 10pF may be needed in an extreme case, to get correct AGC action. When properly adjusted, the rise in volume on each side of the centre tuning point of a station is not great. The Homodyne described by Mr Herbert gives impressive tonal quality but lack of selectivity can be a problem in some areas. We had already tried converting the Playmaster 123 to Homodyne demodulation in the same way as you have done and our experience was much the same. Instability can also be a problem. We dropped the idea as it seemed to introduce problems and the improvement in quality was very small, if any. The two resistors are as recommended by the IC manufacturers. For the average person, we doubt if there is any satisfactory way of testing an IC other than by substitution. However, in general, if an IC is working at all, it can be considered as all right, as failure is usually catastrophic.

DEAD LETTER: We are holding a letter addressed to Mr A. Hashim, 240 Bayswater Rd, Currajong, Queensland, 4812. This has been returned by the postal authorities marked "Address unknown." If Mr Hashim will supply his new address we will forward the letter to him.

TUNER AMPLIFIER: I have constructed the Playmaster 136 stereo amplifier and incorporated it with the Playmaster 131 tuner in the Playmaster 132 cabinet and front panel. My main problem concerns the tuner. While all the voltages appear correct and it receives stations it whistles and heterodynes — picking up high frequency signals all over the band. The tuner has been accurately aligned and checked. Could the problem be in the tuner design? I live 200 miles west of Melbourne and expect to hear all Melbourne stations. I was wondering if the inclusion of an RF stage ahead of the aerial coil would improve the performance. Could you make suggestions?

Is the tuner able to connect to the Playmaster 136 without overload of the preamp input?

My other problem concerns power output of the amplifier. The volume slider control can be advanced to "half max" and then to "max" without the output level changing (using 8 ohm 10in 20W loudspeakers). The speakers do not distort. The level does not seem at a 13 watt level to me. I have accurately checked the output with an AC voltmeter, ammeter and calculated "flat out level" to be only 6 watts. All voltages seem normal. Any suggestions and tests would be greatly appreciated. (D.N., Penshurst, Vic.)

② Errata published in the September 1972 issue should be of help in your problem. This says, in part: "It is

HOW TO USE OUR INFORMATION SERVICES

As a service to readers "Electronics Australia" is able to offer: (1) Project reprints, metal work dyelines, photographs, printed wiring patterns and other filed material to do with constructional projects and (2). A strictly limited degree of assistance by mail or through the columns of the magazine. Details are set out below:

PROJECT REPRINTS: These cost 80c per issue-reprint. Thus, a project spread over three issues will cost \$2.40. Reprints are available for all projects, but no material can be supplied additional to that already published. Reprints can be supplied more speedily if they are positively identified and not accompanied by technical queries. Material not on file can normally be supplied in photostat form at 40c per page.

SUBSCRIPTIONS, BINDERS, HANDBOOKS etc: These are handled by separate departments. For fastest service, send separate orders to the departments concerned.

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REPLIES BY POST: These are provided to assist readers encountering problems in the construction of our projects published within the last two years. Note, particularly, that we cannot provide lengthy answers, or undertake special research or modifications to basic designs. Charge: 80c. Inclusion of an additional fee does not entitle correspondents to special consideration.

OTHER QUERIES: Technical queries outside the scope of "Replies by Post" may be submitted without fee and may be answered in the magazine at the discretion of the Editor. Technical queries will not be answered by interview or telephone.

COMMERCIAL EQUIPMENT: "Electronics Australia" does not maintain a directory of commercial equipment, or circuit files of commercial or ex-disposals equipment etc. We are therefore not in a position to comment on any aspect of such equipment.

COMPONENTS: "Electronics Australia" does not deal in electronic components. Prices, specifications, etc should be sought from appropriate advertisers or agents.

REMITTANCES: These must be negotiable in Australia, and should be made payable to "Electronics Australia". Where the exact charge may be in doubt, we recommend submitting an open cheque endorsed with a suitable limitation.

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most important that the tuning slug in the aerial coil be set to the outermost of the two possible peak positions. This adjustment is most important for correct operation. A second point concerns the 220pF top coupling capacitor. We have found it worthwhile to connect it alternatively to the "top" of the tuned winding (pin 2) and reduce its value to suit the higher impedance. A value of 4.7pF appears to be optimum."

However, the tuner may not be suitable for your location. You may need a tuner of higher performance such as the Playmaster 138 described in December 1972 issue. (File No 2 / TU / 38). Your tuner is not likely to overload the normal (100mV) input of the Playmaster 136.

Concerning your amplifier, it seems possible that you have used a control with a linear characteristic rather than the logarithmic type specified. As far as power output is concerned, your method of checking power is unlikely to give an accurate result. It must be checked using a sine wave source, resistive load, oscilloscope and an AC voltmeter. We suggest you check both power and sensitivity to see that they are within specification. Apart from this, you may have to obtain a more sensitive pair of loudspeakers.

LOUDSPEAKERS: Some time ago I read an article in your magazine on Magnavox loudspeakers. I have since purchased a pair of Magnavox 8.30 (15 ohm) woofers and Philips 1 inch tweeters. I now find myself in the predicament of not knowing the exact dimensions of the loudspeaker boxes (inside). I would like to know the dimensions for the above speakers. (J.M., Hamilton, NSW.)

② The article on the Magnavox 8.30 systems was published in January 1971 (File 1 / SE / 25). There were two enclosures featured, 1cu ft and 1.6cu ft. However, they did not use Philips tweeters and we have not published any information on this modification. Copies of this article are available at the usual fee of 80 cents. ②

THYRISTOR TRAIN CONTROL (March 1967, File 2 MC / 3): Two only 0.47uF capacitors are required, not three as called for in the parts list.

PLAYMASTER 136 (December 1972, File No. 1/SA/39): A reader who was troubled with hum problems reports that he has solved it in the following manner. The +21V terminal on the left channel power board is linked to the same point on the right channel board with a short length of hookup wire. The -21V points are similarly bridged. This completely cured his problem and he feels that others may benefit from his experience. (R.L. Caringbah, NSW.)

SIMPLE MODEL TRAIN CONTROL (April 1974, File No. 2 MC / 10): Some readers have experienced difficulties in obtaining supplies of TT801 transistors. Equivalents for the TT801 are the 2N3053, BFY50, BFY51 and BFY52, and these should be available from the usual suppliers, along with the TT801.

BREADBOARD HOOKUPS, 1974 STYLE. (April 1974): If the Multivibrator (circuit 4) is used to test valve circuitry involving high voltages, it is possible that the peak current through the output capacitor may be too high for the transistors to handle safely. To avoid this connect a 27k ½ watt resistor in series with the 0.1uF capacitor.

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Tone Generator from p77

hot iron with a small tip, and only solder in those pins which are connected into the circuit.

We have left room on the board for the use of a socket for the crystal, but this is not essential. We did not use one, but soldered the crystal direct to the board.

Carefully check the completed board for any errors, particularly with regard to polarity and position.

The only remaining component to be fitted is the tone generator IC. Particular care is required, as this can be damaged by stray electrostatic charges. Hold the IC by the top, and do not touch the pins. Insert it into the socket by pushing firmly, taking care that none of the pins are bent, and that each one enters its correct socket clip.

The board is now complete, and can be put aside until the remaining construction has been finished.

The amplifier for the speaker and the filter and attenuator for the output socket can now be assembled on the tag strip, according to the layout. Also included on this tag strip is the dropping resistor for the pilot light.

Cut the shafts of the switches and the volume control potentiometer to a suitable length, and fit them to the front of the chassis. If desired, the note selection switch can be carefully disassembled and the stop filed off. This will enable the shaft to rotate through 360 degrees completely, making use of the tuner slightly easier.

The remaining components, including the insulated spacers used to mount the board can now be fitted, using the wiring diagram and photographs as a guide.

The speaker is held behind its cutout by four machine screws countersunk into the panel in conjunction with washers and nuts. Details can be seen in the photograph. The screws must be countersunk so that the front panel can be fitted.

We recommend that the wiring between the edge connector and the switches be done using multicoloured wires, as this makes the job much easier and less prone to mistakes. Commence by connecting all the necessary wires to the edge connector.

Once this has been done, position the connector in the approximate position that it will occupy when connected to the printed board, and commence the wiring to the switches. This will have to be done as shown on the wiring diagram. It will be found that the wires from the connector can be grouped in two major bundles, one to each switch.

After completion, check thoroughly that no mistakes have been made. When this has been done, the remaining wiring can be completed.

The printed board can now be screwed to its mounting spacers, and the edge connector pushed firmly home. The tuner is now ready for testing. Plug the mains cord into a suitable receptacle, and switch on. The pilot light should immediately glow. Advance the volume control and listen for a note.

If no sound can be heard, rotate the octave switch: ie the right hand switch. Check that the notes increase in frequency as the switch is rotated clockwise, and that there are no positions where no sound can be obtained apart from the three at either end of the range.

Set the octave switch to the central position. Rotate the note selection switch and check that twelve separate notes can be heard, and that they increase in pitch as the switch is advanced clockwise. If any notes are out of order, check that all connections to the switches are correct.

The front panel can now be fitted. It is held in place by the mounting nuts for the switches and the potentiometer, as well as the pilot light. When fitting the knobs to the switches, ensure that their relative position is correct. The octave switch knob is fitted so that the pointer is vertical when the switch is set to the central octave.

The note selection switch should be positioned so that A=440Hz can be heard when the pointer is vertically upward. If you are unable to tell this note by ear, set the knob so that the change-over between C and C sharp occurs at the correct place. (These notes are nearly an octave apart, and occupy adjacent switch positions.)

The instrument should now be ready for use. ②

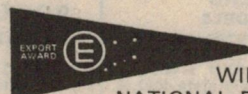


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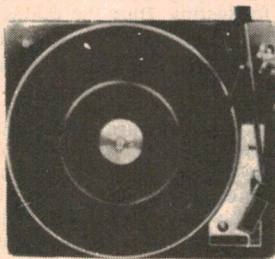
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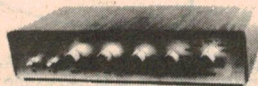


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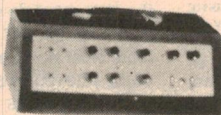
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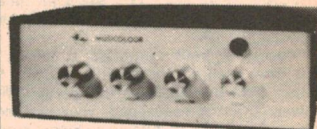
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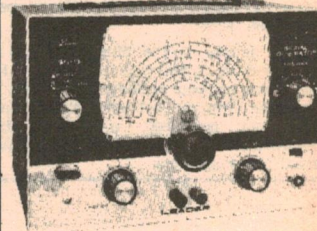
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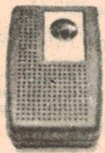
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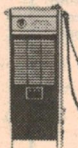
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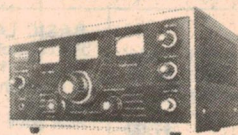
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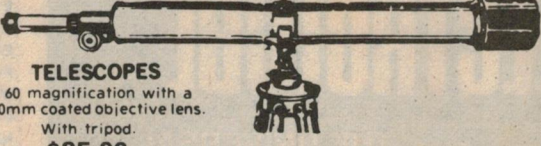
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807	\$1.50	CV850	\$1.50																												
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3 1/4" x 600'	2.20	15																													
5" x 900'	2.50	15																													
5" x 1800'	4.50	20																													
7" x 1200'	3.50	20																													
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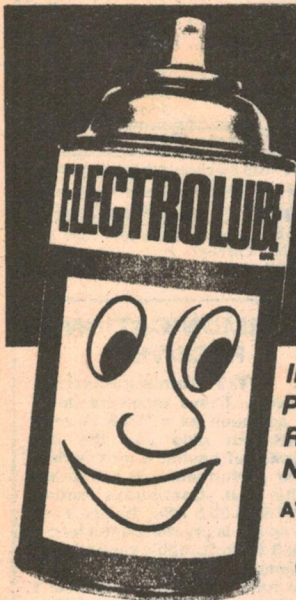
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